



SCIENTIFIC RESEARCH OF THE SCO COUNTRIES: SYNERGY AND INTEGRATION

上合组织国家的科学研究：协同和一体化

**Proceedings of the
International Conference**

**Date:
October 26**

Beijing, China 2022

上合组织国家的科学研究：协同和一体化
国际会议

参与者的英文报告

International Conference
“Scientific research of the SCO
countries: synergy and integration”

2022 年 10 月 26 日，中国北京
October 26, 2022. Beijing, PRC

Proceedings of the International Conference
**“Scientific research of the SCO countries: synergy
and integration”** - Reports in English

(October 26, 2022. Beijing, PRC)

ISBN 978-5-905695-82-7

这些会议文结合了会议的材料 – 研究论文和科学工作者的论文报告。它考察了职业化人格的技术和社会学问题。一些文章涉及人格职业化研究问题的理论和方法论方法和原则。

作者对所引用的出版物，事实，数字，引用，统计数据，专有名称和其他信息的准确性负责

These Conference Proceedings combine materials of the conference – research papers and thesis reports of scientific workers. They examine technical, juridical and sociological aspects of research issues. Some articles deal with theoretical and methodological approaches and principles of research questions of personality professionalization.

Authors are responsible for the accuracy of cited publications, facts, figures, quotations, statistics, proper names and other information.

CONTENTS

ECONOMIC SCIENCES

太空探索中的 IT 技术：俄罗斯在乌克兰开展特种军事行动的视角 IT technologies in space exploration: Russia's Perspective in Conducting a Special Military Operation in Ukraine <i>Kharlanov Alexey Sergeevitch, Boboshko Andrey Alexandrovich,</i> <i>Novikov Maxim Mikhailovich, Ponomareva Evgeniya Valeryevna.....</i>	<i>9</i>
识别有能力成功开展某类活动（例如，计算机软件开发领域的活动）的个人 Identification of individuals with the ability to successfully carry out a certain type of activity (for example, activities in the field of computer software development) <i>Khubaev Georgy Nikolaevich.....</i>	<i>13</i>
军人养恤金规定 Pension provision for military personnel <i>Vafin Eduard Yafasovich.....</i>	<i>18</i>
商品流通领域以数字平台为基础的生态系统发展 Development of ecosystems on the basis of digital platforms in the sphere of commodity circulation <i>Zavyalov Dmitry Vadimovich, Zavyalova Nadezhda Borisovna,</i> <i>Saginova Olga Vitalievna.....</i>	<i>24</i>

JURIDICAL SCIENCES

俄罗斯联邦大气保护的法律法规以解决气候变化的全球环境问题 Legal regulation of atmospheric air protection in the Russian Federation in order to solve the global environmental problem of climate change <i>Zinoveva Olga Anatolievna.....</i>	<i>33</i>
------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------

PEDAGOGICAL SCIENCES

二元亲子关系特征及其对学龄前儿童自尊的影响 Features of dyadic parent-child relationships and their impact on self-esteem in senior preschool age <i>Safaraliev Raziya Aynudinovna.....</i>	<i>40</i>
课堂对话作为“师生”关系的一种形式 Lesson-dialogue as one of the forms of "teacher - student" relationship <i>Krevsun Margarita Vladimirovna, Burshit Irina Evgenievna,</i> <i>Vinevskaya Anna Vyacheslavovna.....</i>	<i>47</i>
远程教授俄语作为外语：动机问题 Teaching Russian as a foreign language remotely: problems of motivation <i>Pomigueva Ekaterina Anatolievna.....</i>	<i>52</i>

中国俄语教师的培养：传统与创新

Preparation of Russian Language Teachers in China: Traditions and Innovations
Xi Zhenxin.....56

CULTUROLOGY

雅库特现代文化空间建筑学中的奥隆霍

Olonkho in the Architectonics of the Modern Cultural Space of Yakutia
*Lyapkina Tatiana Fedorovna, Markova Maria Markelovna,
Strekalovskaya Zoya Andreevna*.....61

PSYCHOLOGICAL SCIENCES

低龄学童对广告影响的心理抵抗形成过程的建模

Modeling of the process of formation of psychological resistance of younger schoolchildren to the influence of advertising
*Gribina Lyudmila Vladislavna, Petrova Nina Vasilievna,
Yurina Alla Anatolyevna*.....66

POLITICAL SCIENCE

中亚地区的中国因素：对安全领域的影响

The Chinese factor in the Central Asian region: the impact on the security sphere
Toropygin Andrey Vladimirovich.....72

MEDICAL SCIENCES

7岁以上儿童急性重度合并颅脑损伤患者每搏血量的昼夜节律

Circadian rhythm of stroke volume of blood in acute severe concomitant traumatic brain injury in children older than seven years
Muhitdinova Hura Nuritdinovna, Alauatdinova Gulhan Inyatdinovna.....78

COVID-19 大流行后第二个成年冠心病女性的身体表现

Physical performance of women of the second adulthood with coronary heart disease after the COVID-19 pandemic
*Boyarskaya Larisa Aleksandrovna, Prokopyev Nikolay Yakovlevich,
Ananiev Vladimir Nikolaevich, Gurtovoy Elisey Sergeevich,
Boyarskaya Elizaveta Alekseevna*.....87

消化性溃疡病的神经源性和遗传因素

Neurogenic and genetic factors of peptic ulcer disease
Ivanov Leonid Nikolaevich, Kolotilova Marina Leonidovna.....95

俄罗斯人群青少年特发性脊柱侧凸患者与健康人UTS2R rs11654140 (T>C) 多态性分布的比较分析

Comparative analysis of the UTS2R rs11654140 (T>C) polymorphism distribution in patients with adolescent idiopathic scoliosis and healthy people in the Russian population
*Buslov Konstantin Grigor`evich, Khalchitsky Sergei Egorovich,
Filippova Alexandra Nikolaevna*.....110

血气成分参数在妊娠期高血压疾病鉴别诊断中的应用

The use of blood gas composition parameters in the differential diagnosis of hypertensive disorders during pregnancy

Chupahin Ruslan Vladimirovich, Khvorostukhina Natalia Fedorovna, Odnokozova Oksana Sergeevna.....116

心脏粘液瘤临床病例

Clinical case of cardiac myxoma

Al-Marwani A.M., Kurkina Nadezhda Viktorovna.....123

PHARMACEUTICAL SCIENCES

龙胆果中花青素和熊果酸含量的研究

Study of the content of anthacyanins and ursolic acid in empetrum nigrum berries

Stoyan Viktoriya Alexandrovna, Butenko Lyudmila Ivanovna, Podgornaya Zhanna Valerievna.....131

CHEMICAL SCIENCES

臭氧脱木质素时的生物质破坏。 臭氧化参数的变化

Biomass destruction when ozone delignification. Variation of ozonation parameters

Mamleeva Nadezhda Alekseevna.....137

臭氧处理分解木结构

Decomposition of wood structure by means of ozone treatment

Mamleeva Nadezhda Alekseevna, Kharlanov Andrey Nikolaevich.....144

TECHNICAL SCIENCE

构建用于控制具有延迟切换的设备的稳健系统

Construction of robust systems for controlling of plants with switching with delay

Ternovaja Galina Nikolaevna, Parsheva Elizaveta Alexandrovna.....153

沿水平井筒（钻孔）的热流运动数学模型的开发

Development of a mathematical model of heat flow movement along a horizontal wellbore (borehole)

Al-Qadasi Omar Khaled Abduljalil Ahmed.....165

确保飞机产品制造质量和精度特性的因素的先验排序

A priori ranking of factors to ensure quality and accuracy characteristics in the manufacture of aircraft products

Zhilenko Vladislav Aleksandrovich, Krasnova Marina Nikolaevna.....171

VETERINARY SCIENCES

复合预防药物“Cesamin”的毒理学评价

Toxicological evaluation of the complex prophylactic drug "Cesamin"

Gavrilov Yuri Anatolyevich, Gavrilova Galina Antonovna, Kruchinkina Tatiana Viktorovna.....178

AGRICULTURAL SCIENCES

萨拉托夫地区小麦产量对农林业和矿质营养的依赖

Dependence of wheat yield on agroforestry and mineral nutrition in the conditions of the Saratov region

Panfilov Andrey Vladimirovich, Popov Valery Gennadievich, Mariskin Roman Valerievich.....186

伏尔加草原林带系统灌溉苜蓿的生产力

Productivity of irrigated alfalfa in the system of forest strips of the Volga steppes

Popov Valery Gennadievich, Panfilov Andrey Vladimirovich, Lazarev Alexander Alexandrovich.....191

伏尔加地区草原带不同农业景观类型的农林牧场耗水量

Water consumption of agroforest pastures by types of agricultural landscape in the steppe zone of the Volga region

Panfilov Andrey Vladimirovich, Popov Valery Gennadievich, Motova Yulia Vladimirovna.....196

不同总砷含量的斑点鲶鱼 (*Anarhichas minor*) 肌肉组织的代谢特征

Metabolic profile of the muscle tissue of the spotted catfish (*Anarhichas minor*) with different contents of total arsenic

Kozin Andrey Valerievich, Abramova Liubov Sergeevna.....201

EARTH SCIENCES

伏尔加-乌拉尔前缘以北局部重力异常区深部构造地质和密度模型

Geological and density models of the deep structure in the area of local gravity anomalies in the north of the Volga-Ural antecline

Konanova Nadezhda Vitalievna.....208

DOI 10.34660/INF.2022.63.51.143

太空探索中的 IT 技术：俄罗斯在乌克兰开展特种军事行动的视角
**IT TECHNOLOGIES IN SPACE EXPLORATION: RUSSIA'S
PERSPECTIVE IN CONDUCTING A SPECIAL MILITARY
OPERATION IN UKRAINE**

Kharlanov Alexey Sergeevitch

*Doctor of Economic Sciences, Candidate of Technical Sciences, Full
Professor, Head Research Officer
Yuri Gagarin Cosmonaut Training Center*

Boboshko Andrey Alexandrovich

*Candidate of Economic Sciences, Associate Professor
Saint Petersburg State University of Architecture and Civil Engineering*

Novikov Maxim Mikhailovich

*Candidate of Economic Sciences, Doctoral Candidate
Saint-Petersburg State University of Economics*

Ponomareva Evgeniya Valeryevna

*Master
The Diplomatic Academy of the Russian Foreign Ministry*

摘要：作者认为，将信息通信技术用于构建人类探索太阳系的任务以及为无人驾驶飞行器和载人航天飞行建立地外基础设施的可能性，是国际合作和各国努力科学统一的趋势 在为寻找地球以外的替代人类居住地而进行的竞赛中。

关键词：SMO、SC “Roscosmos”、NASA、美国、俄罗斯、军备竞赛、ICT、AI（人工智能）、大数据、工业 4.0。

Abstract. *The authors consider the possibility of using ICT in building the tasks of human exploration of the solar system and in building extraterrestrial infrastructure for flights of unmanned aerial vehicles and manned astronautics, as trends in international cooperation and scientific unification of the efforts of all countries in the race to find a place for alternative human habitation outside the planet Earth.*

Keywords: *SMO, SC “Roscosmos”, NASA, USA, Russia, arms race, ICT, AI (artificial intelligence), Big Data, Industry 4.0.*

Held since February 2022, SMO Russia in Ukraine against more than 50 countries of the collective West and all NATO countries for Russian sovereignty and the denazification of the Ukrainian nationalist regime, showed that despite 9 packages of sanctions, which already have a caricature rather than a preemptive character, each country is increasingly entering a politically engaged autarchy. For none of us is rich enough to explore space alone, to build an extraterrestrial infrastructure of human expansion outside the Earth [1]. And the understanding of this imperfection prevents each state from clearly distinguishing between its ambitions and scientific and technical reserves, which become obsolete without their applied and joint technological application, which do not make much sense outside of grandiose plans, alternative schools and scientific hypotheses. And this means that flights to near-Earth orbit will continue, the political situation is expected to change and again acquire the features of a systematic and mutually beneficial discourse on the technical nuances of the most promising and safe movement of various vehicles, probes and the joint training of various countries of crews in the depths of space.

Therefore, the issues of our ICT interaction, including in matters of space programs: while the collective West dreams of making a “big North Korea” out of us, today there is a trend not only for the collection and development of unified regulations in the field of engine building, shipbuilding or the unification of security and control systems life activities on ships of previous technological solutions, but are also moving to the search for the most demanded resources for the transportation and delivery of the goods themselves, for example, between prescribed planned objects of extraterrestrial infrastructure, such as the Lunar Research Station for a wide range of uses, announced by the United States.

And a variant of such a scientific backlog could be an ion-type rocket engine, which should gradually replace the chemical engines of the 1940s, the “V-2”, so actively developed by Wernher von Braun and after that played a key role in the American space program. And such liquid rocket engines that have gone down in history, operating on the principle of the law of conservation of momentum when combining fuel with an oxidizer (kerosene-oxygen), which later developed into impulse (denatation engines), and since 1964, the era of ion engines began (the Soviet spacecraft “Zond-2” was the first to have just such an engine), which gradually evolved and became the basis of the international program “Artemis” and the domestic “Don”, enter into scientific transformation further. Engines on a nuclear power propulsion system are of most concern today to potential deep space researchers, which requires all the earthly cooperation of the world’s leading scientific schools and in 7-8 years already guarantees the receipt of a prototype of such an engine, ready to fly to Alpha Centauri, as previously planned by leading space agencies [2]. And antimatter engines are still very utopian, primarily because of the price (1 gram of antihydrogen will cost 62.5 trillion dollars - 2 US government

debts today), and there is not a single material that could work at such temperatures with antimatter - an explosion at the start of such an engine is inevitable [3].

Therefore, the task, under the conditions of the set of sanctions, retortions and reprisals imposed on us by SMO in materials and in long-term international experiments, will hit our developments and not only research in the field of propulsion of ships, probes and shuttle trucks, but will also destroy partly stable cooperation in the field ICT research: will slow down and impede the convergence of the resulting products to the level of creating their own chips, boards, implemented software and measurement elements, which without neural networks and global ultra-high-speed computers will not be able to give us a technological initiative in questions and calculations, Big Data, as well as for forecasting models of various launch trajectories, and most importantly, will reduce our ecosystem in the “human-robot” dilemma, which is the basis of the 7th scientific and technological order and the basis for further transformation of the digital paradigm of the future society in Industry 4.0. [4]

The task of Russia will no longer only continue flights on “dragons”, as Anna Kikina demonstrates today as part of an international mission that successfully flew to the ISS (International Space Station), but also accept for itself those “red lines” that we have drawn with aggressive competitors who are trying to take away our initiative in space tourism, and in remote sensing of the Earth, and in commercial flights, combining the power of Western scientific thought (which adopted a lot from the Soviet scientific school), and flexible forms of public-private partnership, which Elon Musk and the Ministry of US defense in the “Starlink” project is actively and categorically demonstrated in Ukraine. And we can and must overcome these challenges in cooperation with China (in particular, in our joint Lunar program), with India and its innovative materials science school, with Korean business and Taiwanese IT specialists, who are ready to share with us such important chips that will help us with AI elements in the future ROS (Russian Orbital Station), which is being launched intensively with an eye to the next 5-6 years [5].

This means that SC “Roskosmos” can today, at the meso level of industry cooperation with Rostec, Rosatom, the Russian army and other monopolists from the state can create the necessary and controlled resource of the state defense order and align the demands of the growing cooperation of ideas and technical solutions for our systemic inclusion in devices and electronics of the appropriate level of complexity and critical importance, solve fundamentally involving us in other global projects from Mars to Venus [6].

Our national ICT idea for both space and the military-industrial complex must undergo an examination not only of friendly import substitution or correction of the Ministry of Digital Development’s “road map”, but also accept the Russian register of domestic IT structures and individual professional persons as a unique

option for restoring national security parameters, capable of sharing unique competencies and international outsourcing cooperation from business structures loyal to our country, as well as taking advantage of the gray army of hackers, able to bring software products, hardware and staffing for the ongoing Russian digital transformation, the implementation of national projects, and changing the training of ICT training - the level of pros and analytics, requiring up-to-date compliance with growing risks and threats, as well as our non-linear responses in cyberspace and in any environment of potential retaliation and confrontation.

References

1. Sibel Thomas; *Digital transformation. How to Survive and Succeed in the New Age* \ transl. from Eng. Y. Gimatova; sci. Ed. M. Savitskaya, K. Shcheglov, -M., 2019. P.227-235.
2. Geach, James. *Galaxies. The Great Guide to the Universe*. AST. M. -2022. P.181-183.
3. *Multichannel astronomy* \ Ed.- comp. A.M. Cherepashchuk. M. 2022. P. 112-116.
4. Ford M. *Robots are Coming: Technological Development and a Jobless Future* / Martin Ford; Transl. from Eng.- M.: Alpina non-fiction, 2016.- P? 388-392.
5. Ford M. *Power of robots: How to prepare for the inevitable* / Martin Ford; Transl. from eng. - M.: Alpina non-fiction, 2022.- P. 214-- 217.
6. Thomas Davenport; *Implementing Artificial Intelligence into Business Practice: Benefits and Challenges*/ Transl. from Eng. - M.: Alpina Publisher, 2021. P. 118-122.

DOI 10.34660/INF.2022.12.75.144

识别有能力成功开展某种活动的个人（以计算机软件开发领域的活动为例）
**IDENTIFICATION OF INDIVIDUALS WITH THE ABILITY TO
SUCCESSFULLY CARRY OUT A CERTAIN TYPE OF ACTIVITY
(ON THE EXAMPLE OF ACTIVITIES IN THE FIELD OF
COMPUTER SOFTWARE DEVELOPMENT)**

Khubaev Georgy Nikolaevich

Doctor of Economic Sciences, Full Professor

Rostov State University of Economic

抽象的。提出了一种原始方法，用于识别具有在开发计算机程序领域成功工作的能力的个人。可以假设该方法适用于识别能够进行各种成功活动的个人，例如，在寻找发明或体育领域的人才时以及其他领域。已经确定，使用比较评估对象的功能完整性和意义及其特征的方法不仅可以评估每个选定的心理生理指标的信息“权重”，而且还提供了一个机会——评估正确识别有能力在开发计算机程序领域成功工作的个人的概率。

关键词：原创方法，能力评估，心理生理指标，功能完整性，信息“权重”。

Abstract. An original method is proposed for identifying individuals with the ability to successfully work in the field of developing computer programs. It can be assumed that the method will be suitable for identifying individuals capable of various kinds of successful activities, for example, when searching for talents in the field of invention or sports and in other areas. It has been established that the use of the method of comparative assessment of the functional completeness and significance of objects and their characteristics not only makes it possible to assess the informational “weight” of each of the selected psychophysiological indicators, but also provides an opportunity to assess the probability of correctly identifying individuals who have the ability to successfully work in the field of developing computer programs.

Keywords: original method, ability assessment, psychophysiological indicators, functional completeness, information “weight”.

Formulation of the problem. Let us first recall that “*Abilities are personality traits that are subjective conditions for the implementation of a certain kind of activity ... are found in the speed, depth and strength of mastering the methods and techniques of activity. A high level of ability development is expressed by the*

concepts of talent and genius.” (Universal encyclopedic dictionary. – M.: BRE, 2002. – 1551 P.). Moreover, for different individuals, these abilities can vary quite significantly. So, in [1], on the basis of extensive statistical material, it was established that, *other things being equal* (education, age, etc.), *the labor productivity* of programmers-developers of computer programs can differ by dozens of times. And judging by the magnitude of the *right-sided asymmetry in the distribution* of time spent on hacking the protection of software products by graduate students of the specialties “Applied Informatics” and “Organization of Information Security”, individuals differ *no less* in their ability to successfully to the programming sphere (see, for example, [2]).

The article presents an original algorithm for the implementation of the method for identifying individuals-citizens potentially capable of successfully developing computer programs. The algorithm is based on the use of methods previously developed by the author and tested.

Algorithm for identifying individuals with the ability to successfully carry out a certain type of activity – activities in the field of development of computer programs.

Suppose that in country **Q** there is an urgent need for the accelerated development of information and telecommunication technologies. To this end, it is proposed to quickly identify the maximum possible number of talented programmers and form teams of developers of software systems for various sectors of the economy and management.

But solving such a problem is not at all easy. After all, as shown in the aforementioned work by B. Schneiderman, the *proportion* of individuals in the total population involved in programming, *those* who have precisely such abilities that “*are found in the speed, depth and strength of mastering the methods and techniques of activity*” in the field of programming, unfortunately, is negligibly small.

The proposed algorithm includes the following steps:

Step 1. Formation of a subset of individuals-citizens *who have confirmed* a “high level of development of abilities” in the field of developing computer programs. This group includes winners of programming competitions, and invites leading developers of computer programs from universities and enterprises.

Using a table or a random number generator, the formed group is divided into two subgroups **A** and **B**: the first subgroup is involved in the *search* for “*personality traits that are subjective conditions for the successful implementation of a certain type of activity*”, and the second is intended to control the correctness, or rather, to assess the success of this search.

Step 2. From the set of citizens of country **Q**, using a random number generator, a set of “citizens of the country” is selected, reflecting the real physical structure of the population.

Step 3. Formation of a set of psychophysiological indicators (with a composition of indicators constantly replenished in the process of development of scientific and technological progress), characterizing “*personal characteristics that are subjective conditions for the successful implementation of a certain type of activity*” - activities for the development of computer programs.

Step 4. Evaluation of the values of the selected psychophysiological indicators for individuals, formed at Step 1 and Step 2, and evaluation of the average values of the indicators for the entire population of individuals.

Step 5. Converting the values of each indicator into relative units (in relation to the average value of the indicator for the totality of individuals - see Step 4 and Tab. 1).

Table 1
*The values of psychophysiological indicators of individuals
(programmers and ordinary citizens)*

<i>FL indicators</i>	<i>Values of psychophysiological indicators of FL</i>				
FL-programmers					
S_1	P_1^1	P_{11}^o	...	P_{m1}	P_{m1}^o
...
S_k	P_{1k}	P_{1k}^o	...	P_{mk}	P_{mk}^o
FL-ordinary citizens					
S_{k+1}	$P_{l(k+1)}$	$P_{l(k+1)}^o$...	$P_{m(k+1)}$	$P_{m(k+1)}^o$
...
S_n	P_{1n}	P_{1n}^o	...	P_{mn}	P_{mn}^o
Average value of the indicator	P_{1av}		...	P_{mav}	

Step 6. Sorting in descending order of the relative values of each indicator for the entire population of individuals and splitting the sorted subsets of indicator values into deciles.

Step 7. Identification of those psycho-physiological indicators in which the majority of the best programmers (from subgroup *A*) turned out to be in the first or last deciles.

Step 8. Combining *A* and *B* subgroups of programmers (see Step 1) and assessing the significance (information “weight”) of each of the selected psychophysiological indicators using the method “Comparative assessment of the functional completeness and significance of objects and their characteristics (functions, features, factors)” [3].

Step 9. Analysis of the presence of a relationship between the combined A and B subgroups of programmers according to the selected composition of psychophysiological indicators and assessment of the probability of a successful search for “personality traits” that characterize the presence of abilities (see [4]). For this purpose, carry out:

*Transformation of the matrix of relative values of the subset of psychophysiological indicators selected at Step 7 $\{P_{ij}\}$ into a matrix $\{X_{ij}\}$, consisting of zeros and ones, for example, $X_{ij}=1$ for all programmers of the group $(A+B)$, whose values of the selected indicators fall into the first or last decile (as a result of sorting in descending order of the relative values of each indicator); $X_{ij}=0$, if the programmer’s relative values of the psychophysiological indicator fell into the interdecile range.

Let $Z = \{Z_i\} (i=1,2,...,n)$ - be the set of programmers formed at Step 1. The materials for converting the quantitative values of the indicators are presented in the form of a table $\{X_{ij}\}$.

Let us now consider the interaction of objects (interaction of programmers) Z_i and Z_k ($i, k = 1, 2, ..., n$) and introduce the following notation: $P_{ik}^{(11)}$ – the number of indicators whose numerical values are the same *at the same time* in Z_i and Z_k , i.e. $P_{ik}^{(11)} = |Z_i \cap Z_k|$ - set intersection cardinality $Z_i = \{x_{ij}\}$ and $Z_k = \{x_{kj}\}$ ($j \in 1, m; x_{ij} \mid x_{kj}, x_{ij} = 1$); $P_{ik}^{(10)}$ – the number of units that indicators have Z_i , but missing from Z_k , i.e. $P_{ik}^{(10)} = |Z_i / Z_k|$ - set difference cardinality $Z_i = \{x_{ij}\}$ and $Z_k = \{x_{kj}\}$; $P_{ik}^{(01)}$ – the number of units missing from Z_i but available from Z_k , i.e. $P_{ik}^{(01)} = |Z_k / Z_i|$.

*Let us choose, as a measure of mismatch between objects Z_i and Z_k , the value $S_{ik} = P_{ik}^{(01)} / (P_{ik}^{(11)} + P_{ik}^{(10)})$, and to assess the degree of inclusion, “occurrence” of the object Z_i and Z_k – the value $h_{ik} = P_{ik}^{(11)} / (P_{ik}^{(11)} + P_{ik}^{(10)})$.

*Let’s build matrices

$P = \{p_{ik}^{(01)}\}$, $S = \{s_{ik}\}$, $G = \{g_{ik}\}$, $H = \{h_{ik}\}$ ($i, k \in \overline{1, n}$), where

$g_{ik} = P_{ik}^{(11)} / (P_{ik}^{(11)} + P_{ik}^{(10)} + P_{ik}^{(01)})$ – Jacquard similarity measure.

The graph built according to P , S , G and H gives a visual representation of the relationship between the compared objects-programmers (according to the selected psycho-physiological indicators).

Conclusion. Let the number of the joint group of programmers $(A + B)$ be equal to 100. Then, if it turned out that new *potential candidates for the team of the best programmers* are interconnected according to such values of psychophysiological indicators that more than 80% of the best programmers (and no more than 10% of the country’s population) have, then it can be *assumed* that, according to their *personality traits*, potential candidates will be able to successfully carry out activities in the field of developing computer programs.

[Comment. In those infrequent cases when, despite the possession of not so successful values of psychophysiological indicators (there is no close relationship in terms of knowledge of the selected indicators with the best programmers) a person achieves significant success in a “certain kind of activity”, then, apparently, the positive influence of a mentor, coach]

Conclusion.

1. An original method is proposed for identifying individuals with the ability to successfully work in the field of developing computer programs. It can be assumed that the method will be suitable for identifying individuals capable of various kinds of successful activities, for example, when searching for talents in the field of invention (in industries) or sports (by type) and other areas.

2. Substantially substantiated is a step-by-step procedure for isolating from an ever-expanding unlimited set of psycho-physiological indicators characterizing a personality, a limited desired subset of indicators that characterize “personal characteristics that are subjective conditions for the successful implementation of a certain kind of activity” - activities in the field of developing computer programs.

3. It has been established that the use of the method of comparative assessment of the functional completeness and significance of objects and their characteristics not only allows one to evaluate the informational “weight” of each of the selected psychophysiological indicators (“personality traits”), but also provides an opportunity to assess the probability of correctly identifying individuals with the ability to succeed in the development of computer programs.

References

1. Schneiderman Ben. *Psychology of programming: Human factors in computing and information systems / Translated from English. A. I. Gorlina, Yu. B. Kotova. – M.: Radio and communications, 1984. – 304 P.*

2. Kostin A.M. *Models and methods for estimating labor costs for opening copy protection of market economic information systems: abstr. diss. ... cand. econ. sci.: 08.00.13. – Rostov-on-Don, 2009. – 23 P.*

3. Khubaev Georgy N. *A universal method for optimizing the composition of object characteristics // Scientific research of the SCO countries: synergy and integration (Beijing, China 9 April 2019). – Beijing, 2019. – P. 11-19.*

4. Khubaev G.N. *Ranking of objects by a set of quantitative indicators: a universal algorithm // RISK: Resources, information, supply, competition. – 2018. – № 1. – P. 213-217.*

军人养恤金规定
PENSION PROVISION FOR MILITARY PERSONNEL

Vafin Eduard Yafasovich

*Candidate of Economic Sciences, Associate Professor, Manager,
SI – Department of the Pension Fund of Russia in the Republic of
Tatarstan*

摘要: 每个人都知道拿破仑的名言: “一个不养活自己军队的民族将养活别人的军队。” 退役军人也是如此。 作者考察了从古代到现在俄罗斯军人养老金的形成历史。

关键词: 养老金提供, 养老金的形成, 军人, 养老基金, 支付。

Abstract. *Everyone knows the quote attributed to Napoleon: “A people that does not feed its own army will feed someone else’s.” The same applies to those military personnel who have retired. The author examines the history of the formation of pensions for military personnel in Russia from ancient times to the present.*

Keywords: *pension provision, formation of pensions, military personnel, pension fund, payments.*

In Russia, support for military personnel has been carried out since ancient times. Even in the annals of Ancient Russia, it was mentioned that princes and governors, in case of injury or reaching old age, took care of military personnel and their families. As a rule, such care was expressed in the provision of land. Warriors received land during their service and became nobles. Another way to support the military was feeding, when the amount of in-kind and cash receipts from the cities was established in favor of the combatants. After the Time of Troubles, under Alexei Mikhailovich, in 1663, “medical” payments were established for the wounded.

Officially, the provision of military pensions was formed under Peter I, with the adoption of the Naval Charter, approved on January 13, 1720. The charter of Peter I consisted of five books. The first contained provisions on the highest commanding staff of the navy and articles that determined the tactics of the squadron. The second included decrees on the seniority of ranks, on honors and external distinctions of ships, “on flags and pennants, on lanterns, on salutes and merchant

flags ...". The third book revealed the organization of the warship and the duties of the officials assigned to it. The fourth book consisted of six chapters, which regulated the rules of conduct on the ship, the number of officer servants according to ranks, the procedure for distributing provisions, methods for determining rewards for taking enemy ships, battle wounds and length of service, as well as methods for dividing booty when capturing enemy ships. The fifth book - "On Fines" - was a naval judicial and disciplinary charter. Also attached to the Maritime Charter were forms of ship's reporting sheets, a book of signals and the rules of sentinel service.

The appearance in Russia of the Maritime Charter was associated with a new stage in the history of the country. In the course of the struggle for access to the sea in the shortest possible time, a strong navy was created in the Baltic, which allowed Russia to turn into a maritime power. By 1725 the Russian fleet was one of the strongest in the Baltic. It consisted of 48 battleships and frigates, 787 galleys and other vessels. The total number of teams reached 28 thousand people.

The charter of 1720 became the most important legislative document of the Russian fleet. In terms of completeness of content and depth of presentation, it was the most perfect for the first half of the XVIII century. After revision, the Naval Charter of Peter I was reissued in 1724 and was valid with minor changes until 1797, when it was replaced by a new one that took into account the change in ideas about the methods of warfare.

Then, on January 24, 1722, the Table of Ranks was adopted, which established the material support for military, civilian, court officials and clergy. Subsequently, Elizaveta Petrovna approved the Regulations similar to the Naval Charter for the ranks of the ground forces.

The Victory in the Patriotic War of 1812 had an influence on the further formation of the pension provision for military personnel. The pressure of the public on the domestic policy of the state after its victorious conclusion was stronger than ever, which was reflected in the government's subsequent measures to provide systemic and urgent social assistance, primarily to war heroes, wounded and maimed soldiers and officers. The first general civil pension law in history was issued - the Charter on Pensions of December 6, 1827. This document summarized all the legal provisions on state pensions for employees of various civil departments, which constituted the main contingent of state pensioners. All individual pension capitals were transferred to the state treasury, and all income and fees from these capitals were converted into a single pension capital. From now on, in Russia, state pensions were assigned according to length of service for all ranks of the army and navy, while relying on a unified system of money payments.

In 1869, a specialized pension provision for army servicemen was already adopted. All the military were divided into nine ranks. The size of their pensions from the amounts of the state treasury depended on the category and the number

of years of service. So, for 20 years, serving in a pension was relied on 1/3 of the officer's salary for the last five years, for 25 - 1/2, for 30 - 2/3, for 35 - full salary. These pensions were based on annual deductions from military salaries of 2% to their gradually growing "pension capital".

After the October Revolution, from 1917 to 1922, the Soviet government adopted more than a hundred decrees and orders in the field of social security. By a decree of the Council of People's Commissars of August 7, 1918, disability pensions were introduced for Red Army soldiers and members of their families in the event of the loss of a breadwinner.

In October 1917, the People's Commissariat of State Charity was formed, which in April 1918 was renamed the People's Commissariat for Social Security. The main activities of this commissariat were: provision of crippled soldiers, including the assignment of pensions to them; protection of motherhood and infancy; work in orphanages; distribution of food rations; providing for minors accused of unlawful acts; medical care [1].

The beginning of the social insurance reform is connected with the implementation of the resolution of the Council of People's Commissars of the USSR of March 23, 1937 "On the removal of certain expenses from the state social insurance budget and the change in the rate of insurance premiums". In accordance with it, pension services (assignment of social insurance pensions and their payment to non-working pensioners) were transferred from the jurisdiction of trade unions to the jurisdiction of state social security agencies.

By the Decree of the Council of People's Commissars of the USSR of July 16, 1940, pensions were approved for enlisted and junior conscripts and their families, by the Decree of the Council of People's Commissars of the USSR of June 5, 1941 - pensions to persons of the highest, senior and middle commanding staff of long-term service, employees of the rank and file of long-term service and their families. In addition, on June 26, 1941, the Presidium of the Supreme Soviet of the USSR adopted the Decree "On the procedure for assigning and paying benefits to the families of enlisted and junior military personnel in wartime."

After the adoption of the USSR Law of July 14, 1956 "On State Pensions in the USSR", material support for war invalids, disabled from childhood and birth was carried out at the expense of the union budget, the budgets of the union republics, etc. Enlisted men, sergeants and foremen of military service had the right to a pension in case of disability, their families - in case of loss of a breadwinner.

In 1990–2001, more than 80 federal laws were adopted in the Russian Federation aimed at improving the existing pension system and reforming it. As a result of changes in certain norms of pension legislation, the conditions for pension provision were improved for: citizens exposed to radiation due to nuclear disasters; persons who did military service in the internal affairs bodies and their families;

participants of the Great Patriotic War; education workers and medical workers, as well as some other categories of the population [1].

Thus, the Law of the Russian Federation dated February 12, 1993 № 4468-1 “On pension provision for persons who have served in the military, served in the internal affairs bodies, the State Fire Service, bodies for controlling the circulation of narcotic drugs and psychotropic substances, institutions and bodies” was adopted. penitentiary system, and their families” and Federal Law № 166-FZ of December 15, 2001 “On State Pension Provision in the Russian Federation”, which regulates the conditions and norms for the provision of pension provision at the expense of the federal budget to military personnel, federal civil servants, “Chernobyl survivors”, as well as persons who have not acquired the right to a labor pension [2].

On January 1, 2012, the Federal Law of November 7, 2011 № 306-FZ “On the monetary allowance of military personnel and the provision of certain payments to them” came into force, establishing a new system of monetary allowance and social security for the military. In the event of the death (death) of a military man, a lump sum of 3 million rubles is paid. (previously - 120 salary salaries). Upon dismissal due to being declared unfit for service due to a military injury - 2 (contractor) or 1 million rubles (conscript) (earlier - 60 salaries). It also provides for monthly compensation for disability due to military injury.

Military pensioners receive a pension for seniority or disability through the Ministry of Defense, the Ministry of Internal Affairs, the FSB and a number of other law enforcement agencies. Many military personnel, after being discharged from military service, continue their labor activity as employees in positions not related to military service. In this case, employers make monetary contributions to the mandatory pension insurance system for them, and, subject to certain conditions, military pensioners have the right to receive a pension through the PFR. The table shows the dynamics of the number of military personnel receiving pensions in the Republic of Tatarstan for 2021.

In addition to pensions, retired military personnel are entitled to certain social benefits. Among them, first of all, the monthly cash payment (MCP). This measure of support is established by federal benefits, and today the Pension Fund provides it to military personnel who became disabled in the line of duty (as well as employees of the Ministry of Emergency Situations, internal affairs bodies and firefighters), combat veterans, families of fallen servicemen, Heroes of Russia and the USSR, disabled people and participants Great Patriotic War and their families. More than a million people receive MCP for the indicated reasons.

Table 1
*Dynamics of the number of military personnel receiving pensions
in the Republic of Tatarstan.*

	01.01.2021	01.04.2021	01.07.2021	01.10.2021	01.01.2022
Military personnel who have an old-age insurance pension (according to Federal Law № 156 dated 22.07.2008)	11 176	11 083	11 006	11 024	11 060
Recipients of pensions from among military personnel and members of their families (according to Federal Law № 166 of 15.12.2001)	1 016	1 005	987	973	944

Thus, throughout its history, Russia has supported its soldiers and their families. There is no doubt that military personnel will continue to be supported. Normative acts have already been adopted on the payment of benefits for the children of mobilized employees, such as free travel in transport, free school lunches, free visits to cultural institutions, exemption from subscription fees for kindergarten and meals in kindergartens, etc. In the Republic of Tatarstan, a Decree was signed, according to which each minor child of mobilized residents of the Republic is entitled to a lump sum payment in the amount of 20 thousand rubles. It should be noted that history has shown that the introduction of social support measures for military personnel and their families occurs, as a rule, after or during military conflicts: The Time of Troubles, the Northern War (1700-1721), the Patriotic War of 1812, the First World War and the October Revolution, the Great Patriotic War, the Afghan War, the Chechen War. In the 90s, Russia passed many laws that improve the situation of veterans and military personnel. By establishing numerous socially significant benefits and privileges for military personnel both during the period of military service and after it, the state increases the prestige of military service, retains highly qualified specialists in the armed forces, and confidently confronts new challenges and threats to national security.

References

1. Degtyarev, G.P. *Medical insurance in Russia* / G.P. Degtyarev // *Medical insurance*. – 2012. – № 1.
2. Vafin E.Ya. *Pension provision of military personnel in Russia and abroad* // *Journal "Economics and Entrepreneurship"* № 10 (part 1), 2017. P. 574-576
3. Vafin E.Ya. *The history of the development of the pension system in the Republic of Tatarstan (IX - XXI centuries): from the origins of feudal estate privileges to modern systems of social insurance (educational publication)* // *Kazan*. – 2020. - 228 P.

在商品流通领域以数字平台为基础的生态系统发展

DEVELOPMENT OF ECOSYSTEMS ON THE BASIS OF DIGITAL PLATFORMS IN THE SPHERE OF COMMODITY CIRCULATION

Zavyalov Dmitry Vadimovich

*Candidate of Economic Sciences, Associate Professor,
Head of Department
Plekhanov Russian University of Economics*

Zavyalova Nadezhda Borisovna

*Candidate of Technical Sciences, Associate Professor,
leading research associate
«SAP Next-Gen Lab Plekhanov» scientific laboratory
Plekhanov Russian University of Economics*

Saginova Olga Vitalievna

*Candidate of Economic Sciences, Professor
Plekhanov Russian University of Economics*

抽象的。本文讨论了以数字平台为基础的创业生态系统发展的主要方向。对生态系统的一般特征及其组织形式的分析, 无论作为数字平台创建者的公司的活动领域如何, 都表明了以最终用户为重点的生态系统发展方向的同一性。同时, 企业家作为生态系统的参与者, 对平台解决方案能力的使用范围有限, 这部分是由于中小企业的水平不高和中小企业人力资源开发效率低下。中型企业。数字平台的组织者专注于扩大客户群和 B2C 领域, 但没有足够的动力在商品流通领域创建基础设施、发展工业生产和形成强大的 B2B 生态系统, 尽管该领域具有相关性和需求解决粮食安全问题。

关键词: 创业生态系统, 数字平台, 商品流通, 信息技术, 数字能力。

Abstract. *The article discusses the main directions for the development of entrepreneurial ecosystems that operate on the basis of digital platforms. An analysis of the general characteristics of ecosystems and forms of their organization, regardless of the field of activity of the company acting as the creator of the digital platform, showed the identity of the directions for the development of ecosystems with a focus on the end user. At the same time, entrepreneurs, as participants in ecosystems, use the capabilities of platform solutions in a limited range, which is partly due to the low level of competence of small and medium-sized businesses and the inefficiency of developing human resources in small and medium-sized*

businesses. The organizers of digital platforms are focused on expanding the customer base and the B2C segment, but are not sufficiently motivated to create infrastructure in the field of commodity circulation, develop industrial production and form powerful B2B ecosystems, although this area is relevant and in demand for solving food security problems.

Keywords: *entrepreneurial ecosystem, digital platform, commodity circulation, information technology, digital competencies.*

The theory and practice in the field of developing the business environment allows us to state with confidence the intensive development of a new business model - the ecosystem. This process was facilitated by the improvement of information and communication technologies and services and the involvement of the population and business in the digital economy [1,2]. The high level of competition in the national market and, to some extent, the actions of a number of world players that impede the development of the Russian Federation, stimulate the processes of increasing the presence of business in the digital environment in order to increase the efficiency of commodity circulation.

Exploring the evolution of the business environment, it was revealed that there is no common understanding of the term “ecosystem” and its legal interpretation [3,4,5]. In the document “The concept of general regulation of the activities of groups of companies developing various digital services based on one “ecosystem”” [6], the term “digital ecosystem” is defined as a client-centric business model that combines two or more groups of products, services, information (own production and /or other players) to meet the end needs of customers (security, housing, entertainment, etc.). The RUIE Commission on Communications and Information Technologies proposes in the report “On the Key Aspects of Regulatory Regulation of the Activities of Companies Developing Activities Based on the Ecosystem Business Model” [7] to adhere to the term “ecosystem in the business environment”, which is interpreted as a set of complementary services and services that account of joint integration form additional value for consumers when using them. This definition more reflects the main advantage of ecosystems as an environment for integrating resources to increase customer value.

PRUE research [8,9,10] made it possible to define a business ecosystem as a set and interaction of actors necessary and sufficient to create a certain value proposition or (as an option) a value proposition for a certain segment of consumers. In an ecosystem, one can single out a source (entrepreneur, product, digital platform) that determines the need for an ecosystem and unites its participants. If the source of the ecosystem is an entrepreneur or an entrepreneurial initiative, the ecosystem can be classified as entrepreneurial. In the case when the source is the commercialization of innovation, the ecosystem can be classified as innovative. If the source

is a digital platform that implements the formation of a value proposition for a certain segment of consumers, the ecosystem is classified as a platform ecosystem. This definition is the most capacious and takes into account the essence of integration processes and, if necessary, the technological basis of integration.

Analysis and generalization of the theory and practice of the formation of ecosystems make it possible to single out their general characteristics. These include:

- the presence of a territorial and innovative component in the organization of the ecosystem;
- cross-industry nature that determines the activity of the ecosystem in various markets;
- formation of an ecosystem based on a modern technological environment focused on the use of end-to-end digital platform technologies or solutions that ensure a high level of interaction between system actors;
- data-centricity, capable of enhancing the adaptive properties of the ecosystem through the use of algorithms and mechanisms for data mining;
- a high level of adaptation due to self-organization based on a digital platform.

Practice in the field of commodity circulation has shown the prevalence of two types of business ecosystems: ecosystems by the platform organizing company (anchor company) and transactional ecosystems [11,12]. Ecosystems with an anchor company create or provide goods/services by coordinating market participants and managing the offerings of complementary companies. The consumer is not an active participant in the organization of business processes. Its influence is determined by preferences and needs when choosing a product/service and by the offers of complement companies. An example of such systems in Russia is large industrial companies PJSC Gazprom - a Russian energy company, JSC OSK - a shipbuilding company, state corporations Rostec and Rosatom, which create and use digital industrial platforms for the interaction of suppliers, manufacturers, customers and to solve other problems. Industrial platforms allow enterprises to combine all data in order to maximize the economic effect of the use of end-to-end technologies, synchronize disparate data from all systems and sensors, analyze and verify information for its subsequent transfer to make management decisions. In transactional ecosystems, the relationship between producers of goods/services and customers is realized through a single platform solution. It is these systems that are most widely used in the field of goods distribution in Russia. Producers and consumers of goods and services united in a single information environment use the services offered by the platform, which makes it possible to reduce territorial barriers, increase the client base and expand the partner network and, as a result, ensure business growth.

Recently, the attention of practitioners and scientists has been drawn to the forms of organization of ecosystems [13], which is due to the need for their devel-

opment in the vast territory of the Russian Federation and the application of reasonable regulatory measures. The form of an open ecosystem uses public non-discriminatory criteria for joining participants, and the operator does not limit the internal competition of product suppliers. However, imperatively open systems do not allow filtering unscrupulous ecosystem participants, they have higher risks for the consumer, since there is often uncertainty about the applicable provisions in contracts and consumer protection [14]. There are high risks of personal data leakage [15]. In closed ecosystems, the decision to join participants is made by the operator in a non-public mode. The operator independently determines the level of internal competition of goods suppliers, which, as a rule, is absent. Closed systems provide quality and safety, but (1) slow down the growth of the ecosystem, (2) cause market regulators and the business community to fear monopolization, (3) may limit the entry of producers of goods and services into the markets. It is also possible to implement hybrid systems that combine the properties of open and closed ecosystems, which makes it possible to level the shortcomings of each of the forms of ecosystem organization.

In Russia, large digital ecosystems in the field of product distribution are implemented on the basis of four types of organizing enterprises - banking structures (Sberbank, Tinkoff, VTB), IT companies (VK, Yandex, SoftLin), retail (OZON, X5 Group, Wildberries), classifieds (Avito, From hand to hand, Blizko). Considering the development of entrepreneurial ecosystems from the standpoint of the organizer of a platform solution, it should be noted that this process in all systems is carried out approximately in the same direction, the accumulation of participants in eco-platforms based on their own applications for creating services or with the involvement of partner organizations is carried out. In order to retain customers, all ecosystems use multiservice subscriptions, focusing on the most popular services such as mobile communications, universal online stores, gas stations, food and grocery delivery, online cinemas, etc. [16]. Most ecosystems in the sphere of commodity circulation implement loyalty programs, stimulating repeat purchases and their frequency. A feature of recent years is the building of a financial structure by ecosystems formed by retail and IT companies through the acquisition of small banks. Currently, OZON (Ekom Bank LLC), Wildberries (Wildberries Bank LLC), X5 Retail Group (X5 Bank financial service created by a company whose founders include X5 Group and Alfa-Bank) have their own banks, Yandex (Yandex Bank JSC), VK (VK Pay is a payment system for paying for goods and services on the social network itself, on external websites or in stores).

Ecosystems are able to provide a concentration of entrepreneurial opportunities and increase the competitive advantages of the sphere of commodity circulation and business entities through the creation of added value (Table 1). The platform organizer has a monopoly in the ecosystem, and the value created by

platform solutions is determined not so much by the value of the platform itself, but by services created in most cases by their own efforts or by applications of partners and third-party developers. Thus, the value of the ecosystem increases with minimal efforts of the organizer of the digital platform, which is defined in a number of publications as an ecosystem effect [17]. Reducing the price due to the scale of production and distribution, the sharing of resources, the formation of a consolidated policy for the quality of goods and services, the reduction of business risks, the formation of a management culture based on data analysis. These are just a small part of the new opportunities provided to the business community by ecosystems based on digital platforms.

It should be noted that the development of ecosystems based on an increase in the client base has a number of significant limitations. First, customer experience analysis, which is widespread in platform solution companies, is being used for more and more customer offerings, leading to overconsumption. Secondly, the growth of the client base does not lead to the stability of the sphere of commodity circulation, to the development of its infrastructure and balance in social and environmental aspects.

Platform solutions offer new opportunities, which does not mean using them. For small and medium-sized businesses, there are a number of barriers that should be overcome in the near future.

Considering the prospects for the development of entrepreneurial ecosystems from the perspective of its participants, in the PRUE in the spring of 2022, a survey of entrepreneurs¹ was conducted, which showed that a significant part of respondents uses general-purpose software products (office applications, messaging applications and video chats) in their activities. Moreover, information systems and platforms for data analysis are used only by legal entities (Fig. 1).

¹ The survey involved 220 entrepreneurs from among small and medium-sized businesses, including 29% were individual entrepreneurs, 32% were legal entities or employees of companies, and 39% were self-employed.

Table 1
Value created by ecosystem services based on platform solutions

Value for the end user	Value for ecosystem participants	Value for the entrepreneurial ecosystem in the field of commodity circulation	Social value
Reducing the cost of goods and services due to the network structure of the entrepreneurial ecosystem	Growth in revenue from an increase in customer base Access to new markets	Increased ability to manage the sustainable development of the sphere of commodity circulation by involving national producers in the sphere of commodity circulation	Increasing the level of national food security
Reducing the cost of goods / services	Cost reduction through resource sharing Sharing R&D costs	Growing impact of the entrepreneurial ecosystem on the environment	Improving the environmental situation in the region through the sharing of material resources by the actors
Improving the quality of goods and services	Ability to use new knowledge to improve the quality of goods and services to increase competence	Formation of a modern entrepreneurial culture focused on economic, environmental and social aspects Offering a wide range of goods and services Building a culture of data-driven governance	Stability of the sphere of commodity circulation
Availability of goods and services through the use of ecosystem platform resources	Possibility to expand sales markets using ecosystem platform resources	Business Transparency Access to the core skills of ecosystem participants to implement flexible procedures for responding to challenges and business opportunities	Aligning the level of development of regions Availability of goods and services in a distributed system of container circulation
Reducing the risks of lack of availability of goods / services	Reducing the risks of interaction with suppliers of goods and services through the exchange of information	Reducing the risks of a negative trajectory for the development of entrepreneurial structures	Increasing the involvement of business entities in the sphere of commodity circulation
Use of goods/services of companies with a high reputation	Division social responsibility	Development of social responsibility	Development of social responsibility



Figure 1. Respondents' responses to a request to indicate the digital technologies used in business

The range of tasks solved using information technologies and systems is also extremely limited. Out of the 133 respondents who indicated that information systems are used in their company, 66% solve the problems of accounting and tax accounting, 61% provide customer relationship management. Digital platforms are used by respondents mainly for the sale of goods / services and as an information and advertising channel, and almost all groups of entrepreneurs use digital platforms to complete financial transactions with customers. More often than others, it is practiced by individual entrepreneurs (78.13%) and legal entities (76%). To a lesser extent, digital platforms are used by the self-employed (64.71%). About 20% of entrepreneurs do not use digital platforms for financial transactions.

These studies show the limited use of the capabilities of platform solutions in the implementation of business, which is to some extent due to the level of competence of employees. Only 65% of respondents are proficient in ICT in accordance with job descriptions. However, about 30% of employees are not proficient in digital technologies or the level of proficiency is low. At the same time, only 29% of entrepreneurs involve third-party organizations to improve the skills of employees in the field of ICT, 40% of entrepreneurs solve the problem of computer literacy on their own.

The activities of the leading platform ecosystems in the field of commodity circulation are focused on the B2C model, which adapts to the user and gener-

ates individual recommendations for each. For business, to a greater extent, the ecosystem acts as an aggregator, not striving to develop the infrastructure for the sphere of commodity circulation. At the same time, as noted in the advisory report on ecosystems [13], the structure of the Russian market should have several large national ecosystems that compete with each other and with foreign players, and smaller platforms that satisfy the demand of customers outside the ecosystems. Each such system should include all the key elements of the commodity circulation system, namely, purchasing structures, warehouses, wholesale distribution centers, transport and logistics networks, “last mile” cargo delivery mechanisms, and, most importantly, promote the creation of new manufacturing enterprises both to meet needs of both private clients and businesses.

References

1. *Digital economy: 2022: a brief statistical collection* / G. I. Abdrakhmanova, Ts75 S. A. Vasilkovsky, K. O. Vishnevsky and others; National research University “Higher School of Economics”. – M.: NRU HSE, 2022. – 124 p. – 300 copies. – ISBN 978-5-7598-2599-9 (in the field).
2. Zavyalov D.V., Zavyalova N.B. Problems and prospects for the development of the sphere of commodity circulation in the digital economy // *Economics, Entrepreneurship and Law*. – 2020. – Volume 10. – No. 6. – P. 1701-1720. DOI: 10.18334/epp.10.6.110533.
3. Filimonov I.V. Ecosystem of the Digital Economy: Problems of Subject Identification // *Innovations and Investments*. 2020. №6. pp.51-58.
4. Kolonchin K.V. Conceptual features and main parameters of the industry ecosystem // *Economics, labor, management in agriculture*, No. 12, V.2 (82), 2021. P.80-89. DOI: 10.33938/21122-80.
5. Kukushkin S. N. Determinants of the business ecosystem // *Bulletin of PRUE*. 2021. №3. (117). pp.76-81 DOI: <http://dx.doi.org/10.21686/2413-2829-2021-3-76-81>
6. The concept of general regulation of the activities of groups of companies developing various digital services based on one ecosystem. May 2021 [Electronic document] URL: https://www.economy.gov.ru/material/departments/d31/koncepciya_gos_regulirovaniya_cifrovyyh_platform_i_ekosistem/ (Accessed 08/15/2022).
7. Report on the key aspects of regulatory regulation of the activities of companies developing activities according to the ecosystem business model [Electronic document] URL: <https://rspp.ru/events/news/rspp-podgotovil-pozitsiyu-o-klyuchevykh-aspektakh-normativnogo-regulirovaniya-deyatelnosti-kompaniy--61f960382db7a/> (accessed 08/12/2022).

8. Saginova O.V., Stegareva E.V., Saginov V.L. *Digital platforms for inclusive business // Issues of innovation economy.* – 2022. – Volume 12. – No. 1. – P. 195–208. doi:10.18334/vinec.12.1.114180.

9. Zavyalova N.B., Zavyalov D.V., Saginova O.V. *Methodological aspects of managing the sustainable development of enterprises in the sphere of commodity circulation // Economics, Entrepreneurship and Law.* – 2021. – Volume 11. – No. 2. – P. 251–266. doi:10.18334/epp.11.2.111583

10. Zavyalov D. V., Zavyalova N. B., Kiseleva E. V. *Digital platforms as a tool and condition for the country's competitiveness in the global market for goods and services // Economic relations.* – 2019. – V. 9. – No. 2. – P. 443–454. – 10.18334/eo.9.2.40608. DOI: 10.18334/eo.9.2.40608/.

11. Filimonov O. I., Kasyanenko T. G., Kukhta M. V. *Ecosystem as a new organizational and economic form of virtual business // Actual research.* 2021. No. 48 (75). Part II. pp. 31–41. URL: <https://apni.ru/article/3298-ekosistema-kak-novaya-organizatsionno-ekonom> (date of access: 09/16/2022).

12. Smirnov E.N. *Global digital platforms as a factor in the transformation of world markets // Issues of innovative economics.* – 2020. – Volume 10. – No. 1. – P. 13–24. – doi: 10.18334/vinec.10.1.100699.

13. *Ecosystems: approaches to regulation. Report for public consultations* // URL: https://www.cbr.ru/Content/Document/File/119960/Consultation_Paper_02042021.pdf (date of access: 08/06/2022).

14. Busch C. *Verbraucherschutz in der Plattformökonomie.* // URL: <https://library.fes.de/pdf-files/wiso/14618.pdf> (accessed 08/03/2021).

15. Golovina T.A., Avdeeva I.L., Sukhanov D.A. *Risk Management of Organizations in the Digital Economy. Bulletin of the Academy of Knowledge.* 2022. No. 1 (48). pp.55–61. DOI: 10.24412/2304-6139-2022-48-1-55-61.

16. *Subscription services in Russia in the second half of 2022 [Electronic resource]* URL: <https://frankrg.com/wp-content/uploads/2022/08/29f1932abe0c.pdf> (accessed 28.08.2022).

17. Konopatov S.N., Salienko N.V. *Analysis of business models based on platforms // Economics and environmental management.* 2018. No. 1. P.21–32. DOI: 10.17586/2310-1172-2018-11-1-21-32

DOI 10.34660/INF.2022.76.66.147

俄罗斯联邦大气保护的法律法规以解决气候变化的全球环境问题
**LEGAL REGULATION OF ATMOSPHERIC AIR PROTECTION IN
THE RUSSIAN FEDERATION IN ORDER TO SOLVE THE GLOBAL
ENVIRONMENTAL PROBLEM OF CLIMATE CHANGE**

Zinoveva Olga Anatolievna

*Candidate of Juridical Sciences, Associate Professor
Kutafin Moscow State Law University*

抽象的。这篇文章涉及与以下相关的问题：脱碳；在俄罗斯联邦某些城市进行污染物排放配额试验，并计划在俄罗斯联邦某些主体进行试验；限制温室气体排放；大气空气保护；空气质量标准，以及向空气中排放有害（污染）物质及其有害物理影响的标准。此外，森林等自然资源的重要性，森林是陆地生态系统中温室气体的主要自然汇，碳填埋场是研究和控制地球上气候变化的全球环境问题的方法之一，显示。

关键词：脱碳、排放配额、污染物、温室气体、标准、大气空气、气候、碳垃圾填埋场。

Abstract. *The article deals with issues related to: decarbonization; an experiment on quotas for pollutant emissions, conducted in certain cities of the Russian Federation and an experiment planned to be carried out in certain subjects of the Russian Federation; limiting greenhouse gas emissions; atmospheric air protection; air quality standards, as well as standards for emissions of harmful (polluting) substances into the air and harmful physical effects on it. In addition, the importance of such a natural resource as a forest, which is the main natural sink of greenhouse gases in terrestrial ecosystems, and carbon landfills, one of the ways to study and control the global environmental problem of climate change on the planet, is shown.*

Keywords: *decarbonization, emission quotas, pollutants, greenhouse gases, standards, atmospheric air, climate, carbon landfills.*

According to the Decree of the President of the Russian Federation of April 19, 2017 № 176 “On the strategy of environmental security of the Russian Federation for the period up to 2025” (1), the global challenges to environmental security include the consequences of climate change on the planet, which inevitably affect the life and health of people, state of flora and fauna, and in some regions become a tangible threat to the well-being of the population and sustainable development.

The effect of global climate change has been attributed to an increase in the concentration of carbon dioxide in the atmosphere, which, in turn, is associated with the start of industrial energy systems grew after the entry into force of the Paris climate agreement adopted in 2015 (2), according to which the participating states undertake to provide reduce global greenhouse gas emissions and limit global temperature rise to 2 degrees Celsius. As one of the measures to adapt to climate change, an increasing number of countries are moving to a low-carbon economy.

In continuation of the Kyoto Protocol and the Paris Agreement, in November 2021, the COP26 Climate Conference was held in Glasgow, where representatives of the states once again discussed the agreements on the Paris Agreement. The Conference resulted in the adoption of the Glasgow Climate Pact(3), under which all parties agreed to review and strengthen their current 2030 emission targets in 2022. While this document was adopted amid global tensions, the Glasgow Pact should give impetus to work on long-term strategies to reduce the carbon intensity of the economy and keep them relevant.

At the present stage, the strategic importance of ensuring a sustainable and balanced socio-economic development of the Russian Federation with a low level of greenhouse gas emissions, taking measures to reduce their negative impact on the climate and the environment, as well as planning measures to adapt ecological systems, population and economic sectors to changes is increasing. climate. The strategic planning documents of the Russian Federation note a new approach to the regulation of economic and other activities in order to minimize the negative impact on the environment as a whole, as well as to the regulation of relations in the field of economic and other activities accompanied by greenhouse gas emissions. In the Address of the President of the Russian Federation to the Federal Assembly of the Russian Federation dated April 21, 2021(4), the task was set to reduce the accumulated volume of net greenhouse gas emissions in the Russian Federation to lower values in the period from 2021 to 2050 compared to the European Union, which will help to maintain the growth of global average temperatures well below 2 degrees Celsius above pre-industrial levels and make efforts to limit temperature increases to 1.5 degrees Celsius. The National Security Strategy, approved by Decree of the President of the Russian Federation on July 2, 2021 № 400, among the national interests at the present stage, highlights the sustainable development of the Russian economy on a new technological basis; environmental protection, conservation of natural resources and rational use of natural resources, adaptation to climate change.

The issues of legal protection of atmospheric air in the Russian Federation do not lose their relevance in modern realities, which is confirmed, first of all, by data on the level of air pollution, it is noted in the legal doctrine, follows from the

meaning of acts adopted in the Russian Federation at various levels of exercising power. In 46 cities with a total population of 13.4 million people (12% of the urban population of Russia), the level of air pollution is assessed as very high and high.

In 2018, by Decree of the President of the Russian Federation, healthcare was defined as the national goal and strategic task of the development of the Russian Federation for the period up to 2024. One of the conditions for ensuring a favorable environment and public health is unpolluted atmospheric air, which indicates the direct interest of the state in solving issues related to air pollution.

Until recently, the use and protection of atmospheric air in the Russian Federation was regulated by such regulatory legal acts as the Air Code of the Russian Federation of March 19, 1997 № 60-FZ and the Federal Law of May 4, 1999 № 96-FZ “On the Protection of Atmospheric Air”. The Air Code establishes the legal basis and state regulation of the use of the airspace of the Russian Federation and activities in the field of aviation, and also provides that the Russian Federation has full and exclusive sovereignty over the airspace over the territory of the Russian Federation, including over internal waters and the territorial sea.

The Federal Law “On the Protection of Atmospheric Air” establishes standards for atmospheric air quality, as well as standards for emissions of harmful (polluting) substances into the atmospheric air and harmful physical effects on it. The quality standards include the hygienic standard and the environmental air quality standard, which reflect the maximum allowable maximum content of harmful (polluting) substances in the atmospheric air and in which there is no harmful effect, in the first case - on human health, in the second - on the environment.

For the purpose of state regulation of emissions of harmful (polluting) substances into the atmospheric air, technical emission standards and maximum allowable emissions are established. However, according to Art. 23.1 FZ “On Environmental Protection” of January 10, 2002 N 7-FZ and clause 4 of article 12 FZ “On the Protection of Atmospheric Air”, in case of impossibility of compliance by legal entities, individual entrepreneurs with sources of emissions of harmful (polluting) substances into the atmospheric air, maximum allowable emissions of territorial bodies of the federal executive body in the field of environmental protection may establish temporarily agreed emissions for such sources in agreement with the territorial bodies of other federal executive bodies. Temporarily permitted emissions, temporarily permitted discharges are established for the period of implementation of the environmental protection action plan or the implementation of the environmental efficiency improvement program in accordance with the schedule for achieving the established allowable emission standards, allowable discharge standards, technological standards.

According to N.I. Khludeneva “... the practice of implementing the provisions of paragraph 4 of Art. 12 of the Federal Law “On the Protection of Atmospheric

Air” in the version that was in force until January 1, 2019, often showed that the deadlines for the phased achievement of maximum allowable emissions were constantly extended by the state authorities of the constituent entities of the Russian Federation, and plans to reduce emissions of harmful (polluting) substances into the atmosphere contained little effective environmental protection measures. In this regard, having retained the possibility for the owners of existing sources of emissions of harmful (polluting) substances into the atmospheric air to not comply with the established standards for permissible impact on it, the Russian legislator did not rule out a further potential deterioration in the state of the atmospheric air”(5).

In order to reduce the level of atmospheric air pollution in large industrial centers, the “Clean Air” federal project has been developed. The project set a number of important tasks aimed at improving the quality of atmospheric air in the most “dirty” cities of Russia - Bratsk, Krasnoyarsk, Lipetsk, Magnitogorsk, Mednogorsk, Nizhny Tagil, Novokuznetsk, Norilsk, Omsk, Chelyabinsk, Cherepovets, Chita. In the course of implementing measures to achieve the goals established by the mentioned federal project, a specialized Federal Law of July 26, 2019 № 195-FZ “On conducting an experiment on quotas for pollutant emissions and amending certain legislative acts of the Russian Federation in terms of reducing air pollution” was adopted”, in accordance with which a comprehensive action plan is approved in these cities to reduce emissions of pollutants into the atmospheric air. The experiment on emission quotas based on consolidated calculations is being carried out from January 1, 2020 to December 31, 2026.

In order to expand the list of cities included in the emission quota experiment, air pollution in the city is defined as high and very high if such pollution has been established for at least three years during the five-year period preceding the year in which such pollution was determined. From September 1, 2022, the territories of the experiment will include, among other things, urban settlements and districts with high and very high air pollution.

The experiment is also dedicated to the Federal Law of March 6, 2022 № 34-FZ “On Conducting an Experiment to Limit Greenhouse Gas Emissions in Certain Subjects of the Russian Federation”. The experiment provided for by this document is being conducted on the territory of the Sakhalin Oblast from September 1, 2022 to December 31, 2028 inclusive, in the territories of other subjects of the Russian Federation included in the experiment - within the time limits established by amending the said Federal Law of March 6, 2022 № 34-FZ.

Decree of the President of the Russian Federation of November 4, 2020 № 666 “On the Reduction of Greenhouse Gas Emissions” provided for the reduction of greenhouse gas emissions by 2030 to 70% compared to 1990 levels, the development and approval of the Strategy for the socio-economic development of the Russian Federation with low greenhouse gas emissions until 2050, as well as

ensuring the creation of conditions for the implementation of measures to reduce and prevent emissions of greenhouse gases, as well as to increase the absorption of such gases. Federal Law № 296-FZ of July 2, 2021 “On Limiting Greenhouse Gas Emissions” forms the necessary legal basis for obtaining complete and reliable information from organizations on greenhouse gas emissions; the obligation of economic entities, whose activities are accompanied by significant greenhouse gas emissions, to submit reports on greenhouse gas emissions to the authorized body is fixed; provides for the right of legal entities and individual entrepreneurs to implement climate projects. According to the above Federal Law, from January 1, 2023, enterprises that emit greenhouse gases per year into the atmosphere, the mass of which is equivalent to more than 150 thousand tons of carbon dioxide, will have to provide reports on these emissions. For enterprises with annual greenhouse gas emissions of 50 thousand tons or more, mandatory reporting will come from January 1, 2025. In pursuance of this law, Decrees of the Government of the Russian Federation dated March 24, 2022 № 455 “On approval of the Rules for verifying the results of the implementation of climate projects” and dated March 30, 2022 № 518 “On the procedure for determining the fee for the provision of services by the operator for conducting operations in the register of carbon units” were adopted.

The strategy for the long-term development of the Russian Federation with low greenhouse gas emissions until 2050 establishes, as part of the first, nationally determined contribution to the global response to climate change under the Paris Agreement, capping greenhouse gas emissions by 2030 at 67% of reported emissions in 1990, taking into account emissions and removals from forestry and land use. It should be noted that forests are the main natural sink of greenhouse gases in terrestrial ecological systems. Russia is the leading forest power in the world, having natural capital in the form of forests accumulating 625 million tons of greenhouse gases annually. This gives Russia significant competitive advantages, since the absorption of greenhouse gas emissions by forests occurs without significant costs from the state, the cost of measures to reduce emissions - for example, to extinguish forest fires - is moderate (3 billion rubles per year) compared to other types of measures, for example, to improve energy efficiency in industry. In general, in Russia there is a huge and still not used reserve for reducing the carbon footprint of products due to the existing protective and other categories of forests on agricultural lands. Forests located on agricultural land are of great importance for the absorption of greenhouse gases. If 1 hectare of forests on the lands of the forest fund on average absorbs about 1 ton of greenhouse gases per year, then 1 ha of protective and anti-erosion forests on agricultural lands - about 7 tons per year, that is, 7 times more. At the same time, according to various estimates, from 40 to 90 million hectares of agricultural land in Russia are overgrown with forests, which are not yet taken into account in the national statistics of greenhouse gas absorption due to the fact that they do not belong to managed forests. Forest

breeding should be aimed at obtaining varieties and species with high growth rates and high potential for carbon sequestration in the climatic conditions of Russia.(6)

The transition to a low-carbon economy is a national priority for the Russian Federation in the long term. One of the ways to study and control the global environmental problem of climate change on the planet is carbon polygons. Since 2021, the Ministry of Agriculture of the Russian Federation, together with the Ministry of Science and Higher Education of the Russian Federation, has been implementing a pilot project to create carbon landfills, agricultural carbon farms for the development and testing of carbon balance control technologies, research into the impact of modern crop cultivation technologies on carbon absorption. At landfills, measurements are made of the ability of a particular territory to capture and store carbon from the atmosphere, then the data obtained can be extrapolated to larger areas. It is necessary to study these indicators as part of the global desire to reduce greenhouse gas emissions, including CO₂, which directly affect the rate of global warming and the melting of glaciers that upset the ecological balance on the planet. In addition, diverse studies and experiments are being carried out, involving the cultivation of highly productive plantations, the restoration of anthropogenically disturbed lands, the irrigation of peatlands, the restoration of wetlands, rational forest management and reforestation, regenerative agriculture and animal husbandry.

According to the Order of the Ministry of Education and Science of the Russian Federation of February 5, 2021 № 74 “On test sites for the development and testing of carbon balance control technologies”, a carbon landfill (polygon) is one or more areas of the earth’s surface with a topography representative of the territory, the structure of vegetation and soil cover, on which a set of measures is being implemented aimed at developing scientific, human and infrastructural potentials in the development and testing of technologies for monitoring the balance of climatically active gases in natural ecosystems. At the carbonic range, experiments are being carried out to measure the emission (emissions) and absorption of greenhouse gases using ground-based and remote methods to assess the spatial and temporal variability of the flows of climatically active gases, as well as to determine the integral values of the components of the radiation, heat, water and carbon balance. In addition, the training ground provides highly qualified personnel in the field of the latest methods of environmental control, promising technologies for the low-carbon industry, agriculture and municipal economy. The result of the activities of the carbon landfill is the development of technological solutions for monitoring the carbon balance based on a complete (completed) technological cycle, as well as their testing in real and critical conditions. The life of the landfill is at least 15 years.

The operator of the carbon landfill is an educational organization of higher education or a scientific organization that implements the program for the creation and operation of the carbon landfill.

Carbon polygons make it possible to carry out a number of important research in the field of ecology. For example: development and adaptation of ground-based technologies for field and forestry agrochemical control of soils and respiration of greenhouse gases; development and adaptation of technologies for remote accounting of above-ground and underground phytomass, rhizosphere, agrochemical control of soils and respiration of greenhouse gases; development and adaptation of mathematical models for primary gross productivity, primary net productivity, net CO₂ exchange between the ecosystem and the atmosphere, respiration and other parameters of the carbon balance of ecosystems in reference areas.

The first carbon test site was opened in September 2020 in the Kaluga Oblast, in 2021 pilot carbon test sites were created in the territories of the Republic of Tatarstan, the Chechen Republic, Krasnodar Krai, Kaliningrad Oblast, Novosibirsk Oblast, Sakhalin Oblast, Sverdlovsk Oblast, Tyumen Oblast to develop and test control technologies carbon balance, conducting research on sources and sinks of greenhouse gases, in 2022 it is planned to increase the number of these carbon landfills in order to cover various types of ecosystems characteristic of the territory of the Russian Federation. It is planned to create 80 similar scientific sites in the country. The implementation of the project is at the stage of development, and it is too early to draw conclusions about the role and importance of carbon landfills in the field of studying and controlling the global environmental problem of climate change on the planet.

References

1. *Decree of the President of the Russian Federation "On the National Security Strategy of the Russian Federation" dated July 2, 2021 № 400 // Collection of legislation of the Russian Federation, 24.04.2017, N 17, P. 2546.*
2. *Paris Agreement: adopted on 12 December 2015 – Text: electronic // United Nations: official website. – // URL: https://unfccc.int/sites/default/files/russian_paris_agreement.pdf.*
3. *Outcomes of the Glasgow Climate Change Conference // URL: <https://unfccc.int/process-and-meetings/conferences/glasgow-climate-change-conference-october-november-2021/outcomes-of-the-glasgow-climate-change-conference>.*
4. *Russian newspaper, N 87, 22.04.2021.*
5. *Actual problems of land, urban planning and natural resource law: a textbook for masters / otv. ed. O.A. Zinoviev, N.O. Vedyshv. M.: Prospect Publishing House, 2019. 275 p. P. 271.*
6. *Carbon farming – a new direction in the climate confrontation // https://www.ng.ru/ng_energiya/2021-06-07/14_8167_climate.html.*

二元亲子关系特征及其对学龄前儿童自尊的影响

FEATURES OF DYADIC PARENT-CHILD RELATIONSHIPS AND THEIR IMPACT ON SELF-ESTEEM IN SENIOR PRESCHOOL AGE

Safaralievna Raziyat Aynudinovna

Educational-Psychologist

MAPEI "Kindergarten № 30 "Little Ship"

抽象的。尽管父母和孩子之间的依恋关系对孩子的自尊很重要，但关于父母在多大程度上对学龄前儿童自尊形成的独特贡献的知识还不够完整。

在这方面，本文致力于研究二元亲子关系的特点及其对学龄前儿童自尊的影响。特别关注家庭教育方式与父母个人素质的关系，孩子个性的形成过程，孩子的适应水平，适应社会环境条件的能力。

笔者揭示了二元亲子关系的特点和家庭教育方式的表现，分析了影响父母行为策略选择的以下因素：首先，父母自身成长的气质类型和传统，兄弟姐妹在家庭中的存在，出生顺序和兄弟姐妹之间的关系等。

以二元亲子关系和家庭教育策略对学龄前儿童自尊形成的影响为主题，以及家庭二元关系矫正的任务和方向作为影响的一部分，得出结论。孩子为了形成足够的自尊，在学龄前的高龄儿童都有说明。

进一步研究的前景是考虑在亲子关系框架内形成足够自尊的方向，以及对父母的影响。

关键词：自尊，学龄前儿童自尊，自尊水平，自尊充分性，自尊形成，自尊形成因素，家庭二元关系，亲子关系。

Abstract. *Despite the importance of the attachment relationship between parents and children for the self-esteem of the latter, knowledge about the extent to which parents make a unique contribution to the formation of self-esteem of children of older preschool age is not complete enough.*

In this regard, the article is devoted to the study of the features of dyadic parent-child relationships and their influence on self-esteem in senior preschool age. Particular attention is paid to the relationship between the style of family education and the personal qualities of parents, the process of forming the personality of the child, the level of his adaptability, the ability to adapt to the conditions of the social environment.

The author reveals the features of dyadic parent-child relationships and manifestations of family education styles, analyzes the following factors influencing

the choice of behavioral strategies of parents: first of all, the type of temperament and traditions in which the parents themselves were brought up, the presence of siblings in the family, birth order and relations between brothers and sisters, etc.

Conclusions are drawn in the context of the topic of the influence of dyadic parent-child relationships and family education strategies on the formation of self-esteem in senior preschool age, and the tasks and directions for correcting family dyadic relations as part of the impact on the child in order to form adequate self-esteem in children of senior preschool age are indicated.

Prospects for further research are the consideration of directions for the formation of adequate self-esteem in the framework of parent-child relationships in relation to the impact on parents.

Keywords: *self-esteem, self-esteem of preschool children, level of self-esteem, self-esteem adequacy, self-esteem formation, self-esteem formation factor, family dyadic relations, parent-child relationships.*

The main task for the mental, emotional and social health of a person is to build his adequate self-esteem. Self-esteem is a term used to describe how a person sees himself, how he perceives his value to the world, and how valuable he thinks he is to other people [3]. In general, people are motivated to maintain high levels of self-esteem and to defend their self-esteem when it is threatened. Self-esteem is important because it is a human need, vital for survival and normal healthy development. According to A. Maslow [2], psychological health is impossible until the essential core of a person is fundamentally accepted, loved and respected by others and by himself. High self-esteem is associated with productive coping strategies, increased motivation, and a positive emotional state. In addition, it has been noted that people with higher and more stable self-esteem tend to have greater life satisfaction and greater optimism about the future and better physical health than people with lower self-esteem. A person with low self-esteem will be more conflicted and will not cope well with the stresses of life. Many studies point to a link between conflicting self-image and various psychological problems [1].

The family is the primary cell of the social community of people, the oldest and one of the most important social institutions. The main value of the family lies in the reconstruction of generations, their upbringing and the institutionalization of the individual as a whole. The role of the family in human life is extremely great and multifaceted. Unlike other social institutions, it affects a person throughout his life, occupying a special place in childhood. At the same time, the child-parent relationship largely influences the physical and psychological development of the child.

In Russian psychology, traditional approaches to the study of the development of the child's psyche in the process of relations with parents are based on the

cultural and historical theory of mental development by L. S. Vygotsky, the provisions of the theory of activity of A. N. Leontiev and the concept of the genesis of communication by M. I. Lisina. According to the authors' research, a child is a social being that enters the world of adults with its cultural and historical laws and realizes activity in it in the form of activity. Extensive research on human parenting has shown that the quality of care is important in determining the level of socio-emotional as well as cognitive development of children. In particular, sensitive and responsive parenting promotes secure attachment relationships, which in turn are predictably associated with positive outcomes in many areas of child development [3]. When interacting with others, children, especially preschool children, have a need for love and care, which are more important than many physical needs, and love and care contribute to the formation of positive self-esteem [2]. But, despite the importance of parent-child attachment relationships for self-esteem, the question still remains open to what extent parent-child dyad relationships make a unique contribution to the self-esteem of older preschool children.

The rationale for considering the separate influences of the attachment relationship between father, mother, and child stems from two theoretical points of view.

First, attachment theory describes that both infants and older children's attachment relationships to their mothers and fathers can be different and complementary and thus parent-specific [8].

Second, family systems theory suggests that the family as a whole is greater than the sum of its parts and has attributes that cannot be understood simply from the combined characteristics of each family member. The family is a hierarchically organized system consisting of smaller subsystems that are interdependent and have a constant and mutual influence on each other [7].

Parenting styles as a group of attitudes and behaviors regarding the upbringing of the individual include two main styles: sensitive, based on warmth, mutual support and proper autonomy, maintaining firm and consistent restrictions on children; and coercive, based on physical punishment, lack of consistency, and inefficient setting of limits. Styles of family education are formed under the influence of objective and subjective factors.

The tactics of raising children in the family can be attributed to one of the styles of interaction:

- 1) dictation (as a rule, in such families, children live in fear, constantly hypocrite, lie, resulting in various deviations in their behavior;

- 2) guardianship (under such conditions, the child is deprived of the opportunity to form the necessary volitional qualities in himself, objectively assess himself, his abilities, purposefully work on himself, which deforms his inner world, value system, sharply reduces or overestimates his requirements for the environment);

3) liberalization as non-intervention (this creates alienation of children and parents, and children, without proper support from their parents, often feel difficult in situations that their peers will easily cope with);

4) cooperation (parents try to be comrades-in-arms of children, are open and sincere with them, help in all matters, skillfully lead to solving problems, thanks to which children discover new opportunities in themselves, gain confidence in their abilities) [5].

The choice of the style of family education by parents is primarily influenced by the type of temperament, the traditions in which the parents themselves were brought up, the scientific and pedagogical literature that they refer to when choosing the style of communication with the child.

An analysis of the scientific literature indicates that parenting styles are a reflection of how parents react to their children and put forward demands on them. Parenting practices are specific behaviors, while parenting styles represent broader patterns of parenting practices. There are different theories and opinions about the best ways to raise children, as well as different levels of time and effort that parents are willing to invest. At the same time, the values of the spouses, both vital and family, acquired in the process of creating and functioning of the family, play a certain role in family relations, the features of interaction between parents and the child, and the formation of the type of family life [6]. The style of family education can directly affect the level of self-esteem, which determines the activity of the individual, her desire for self-education, her participation in the life of the team.

Empirical evidence on the relationship between quality of parental attachment relationships, parenting style, and a child's self-esteem is mixed. However, most research findings have shown that children's self-esteem is related to parent-child relationships and family characteristics. The results of the study showed that parents of children with low self-esteem tend to severely punish their children, while in the group of children with high self-esteem, the family showed a more democratic way of interaction [4].

In addition, there is a gender theory that suggests that gender plays a central role in family roles and behaviors of both parents and children. It is argued that boys and girls will be treated differently because boys will be socialized in male gender roles and girls in female gender roles [8].

Birth order and relationships between siblings can also play a role in children's self-esteem. On the basis of both reflective assessments and social comparisons, first-born children can be expected to have higher self-esteem than later children [6].

Along with marital ties, parental ties are a major source of self-esteem for most adults. How parents fulfill the roles associated with these identities, how their

children respond to them, and the quality of the relationship between parents and children are of great importance for the self-esteem of both. Research shows that mothers with low self-esteem are more prone to child abuse and neglect. However, there are many factors that refine or soften this model [9].

Taken together, most studies show that both maternal and paternal attachment relationships contribute to a child's self-esteem. Each person has their own stable characteristics, such as temperament, gender, genetic makeup or ethnicity. It is hypothesized that these stable individual characteristics may also influence or confound the predictor (perceived quality of the parent-child attachment relationship) and/or outcome (the child's self-esteem) in the study, and therefore it is important to control them.

It should be summarized that the relationship between parents and children can be influenced by several psychosocial and socio-demographic risk factors that undermine their quality and, in turn, play a negative role in the short and long-term psychological health of the child and, accordingly, in the formation of adequate self-esteem. Also, well-established models of parenting postulate that the quality of parent-child relationships is the integrated result of three sets of factors: parental characteristics, child characteristics, and context, which can influence parenting in a supportive or stressful manner.

Solving optimization and efficiency issues requires not just improving existing practice, but also carrying out a scientific search for the best or only possible way under given conditions, which would provide the most rational way to achieve the expected results.

Prevention and intervention programs that support parenting skills in at-risk families can effectively reduce the impact of risk factors on a child's self-esteem. The most important task for every parent is the affirmation and formation of their own "I" in each child. Accumulating a series of successful experiences can help solidify their self-image as something positive. They are more likely to have a positive self-image if they feel they are capable of adequately fulfilling their role, depending on the group they belong to (particularly the family). Determining the pedagogical conditions for the formation of parent-child relationships for the formation of adequate self-esteem of children, it can be noted that the success of the identified pedagogical conditions depends on:

- clarity of formulation of the final goal and result;
- understanding that in order to improve the pedagogical process, it is worth highlighting a set of pedagogical conditions;
- taking into account the fact that pedagogical conditions appear at certain stages of the study as a result achieved through their implementation.

Guided by these considerations, the pedagogical conditions can be represented as a certain way organized system for the formation of relationships between older

preschool children and their parents. This system provides for the implementation of educational work simultaneously in three areas:

- work with older preschool children;
- work with parents;
- work with the teaching staff.

Due to taking into account the needs of the family (children and parents in particular), it is aimed at achieving a certain result, in our case, increasing the efficiency of forming an adequate self-esteem within the framework of child-parent relationships. Highlighting the pedagogical conditions, it is necessary to proceed from the fact that the formation of parent-child relationships will be productive only if they are comprehensively implemented. We list the pedagogical conditions for optimizing the process of forming an adequate self-esteem, aimed at the work of a psychologist with children of senior preschool age:

- enrichment of the cognitive, emotional-value and behavioral-activity components of the relationship between preschoolers and parents in the process of educational work of a preschool institution;
- organization of joint cultural and leisure activities of parents and children, aimed at optimizing the relationship between them in order to form an adequate self-esteem in the child.

So, the process of forming an adequate self-esteem in relation to the impact on the child is realized on the basis of the assimilation by children of senior preschool age of knowledge about self-esteem, positive qualities and relationships, their emotional experiences and the positive experience of these relationships in interaction with parents and other family members.

Prospects for further research are the consideration of directions for the formation of adequate self-esteem in the framework of parent-child relationships in relation to the impact on parents and teachers of a preschool institution.

References

1. Leontiev D.A. *Self-regulation, resources and personal potential* / D.A. Leontiev // *Siberian Psychological Journal*. - 2016. - № 62. - P. 18-37.
2. Maslow A.H. *Motivation and personality* – 3rd ed. Transl. from Eng. Gutman T., Mukhina N. SPb.: Peter, 2019. 352 P.
3. Todorova M.S. *Self-assessment as a factor in the sociometric status of children in a group* / M.S. Todorova // *Prospects for science and education*. - 2014. - № 5 (11). - P. 94-98.
4. Uruntaeva G.A. *Studying by a teacher of a preschooler: approaches and methods* / G.A. Uruntaeva, E.N. Gosheva // *Modern preschool education. Theory and practice*. - 2017. - № 5 (77). - P. 18-27.

5. Brown G. L., Mangelsdorf, S. C., Neff, C. *Young children's self-concepts: associations with child temperament, mothers' and fathers' parenting, and triadic family interaction. Merrill Palmer Q.* (2009). 55, 184–216.

6. Han Z., and Guo, Z. *The impact of grandparenting on feeling of loneliness and mental health of children in rural area. South China J. Prev. Med.* (2016). 42, 167–170.

7. Krauss S., Orth U., Robins R. *Family Environment and Self-Esteem Development: A Longitudinal Study from Age 10 to 16. Journal of Personality and Social Psychology.* (2020). 119. 457-478.

8. Thompson R.A. *Early attachment and later development: Reframing the questions. In: Cassidy J, Shaver PR, editors. Handbook of attachment: Theory, research, and clinical applications. New York, NY: Guilford Press; 2016. P. 330–365*

DOI 10.34660/INF.2022.17.91.149

作为“师生”关系形式之一的课堂对话

LESSON-DIALOGUE AS ONE OF THE FORMS OF «TEACHER - STUDENT» RELATIONSHIP

Krevsun Margarita Vladimirovna

*Candidate of Pedagogic Sciences, Full Professor, Head of Department
Anton Chekhov Taganrog State Institute*

Burshit Irina Evgenievna

*Candidate of Pedagogic Sciences, Associate Professor
Anton Chekhov Taganrog State Institute*

Vinevskaya Anna Vyacheslavovna

*Candidate of Pedagogic Sciences, Associate Professor,
Anton Chekhov Taganrog State Institute*

抽象的。教育过程中不同学科之间互动的教学法被认为是当今学校发展中最紧迫的问题之一。该文章的作者将这种教学互动的特征描述为一种教育对话，其形式、结构在这方面揭示了教育过程中主体的作用。文章分析了影响教育对话成功的因素。

关键词：对话，互动，教育演讲情境，教育对话结构，形式，因素。

Abstract. *Pedagogy of interaction between various subjects of the educational process is recognized today as one of the most urgent problems of school development. The authors of the article describe the features of this type of pedagogical interaction as an educational dialogue, its forms, structure, reveal in this regard the roles of the subjects of the educational process. The article analyzes the factors influencing the success of the educational dialogue.*

Keywords: *dialogue, interaction, educational speech situation, structure of educational dialogue, forms, factors.*

In the value picture of the formation of the world, one of the main roles is assigned to communication, and dialogue is considered an integral property of the historical and civilized formation of society. For this reason, the doctrine of dialogue is inextricably linked with the development of various areas of social life [1].

“Communication is the process of development and formation of relations between subjects that are actively involved in the dialogue. The teacher’s speech is

the main means that allows him to introduce students to his ways of thinking” [7, p. 625].

Scientists - specialists in psychology note that in order to achieve the goal of full-fledged dialogical communication, specific skills are needed:

- quickly and competently navigate in the circumstances of communication;
- systematically think over your own speech, according to the tasks and conditions, time and situation;
- correctly choose the essence of the act of communication;
- find appropriate resources to deliver the content;
- guarantee feedback.

T.L. Arakelova, S.N. Batrakova in their studies showed that all elements of the act of dialogical communication, without exception, must be provided for and observed. A significant feature of communication is the level at which there is contact between participants [1; 2]. Along with this, it must be borne in mind that each of the levels of communication achieves an effective result only when communication barriers do not appear. However, in reality, it is very difficult to exclude them.

Ethical and logical barriers to dialogic interaction, which must be taken into account in pedagogical practice, are absolutely surmountable if the focus on school dialogue is established as a system of teacher's work, since the success of training depends both on the correct formulation of its goals and content, and on the method of achieving the goals.

Using dialogue as a way of teaching, the teacher outlines its topic, prepares a dialogue, predicts the result, plans the development of a dialogue in which the participants in the educational process interact. It goes without saying that schoolchildren have a desire to realize their own communicative need during the lesson. This can be done in a dialogue that directly depends on the communicative work of the teacher. Only a teacher who perfectly understands the characteristic features of school dialogue is able to create a dialogic environment in the classroom. Today, in progressive science, a difference has been established between educational and domestic dialogue, educational and artistic, educational and exclusively scientific.

The educational dialogue constantly takes place on the basis of the educational speech situation, such a dialogue solves either one or the other educational tasks. During the educational dialogue, there is a constant interchange of information data, and interpersonal relationships are regulated. The basis of the educational dialogue is always the subject of discussion, which can be considered from various positional points of view [9].

Motivational scenarios of educational dialogue contain in their structure a moment, the essence of which is the aspiration of students to solve specific educational problems. This stage makes it possible for the teacher to build educational work

in a dialogue with students in such a way that self-realization of each individual takes place, there is a high probability of obtaining a positive result of the teaching.

It should be noted that the peculiarity of the educational dialogue is interconnected with the distinctive features of the dialogue as a whole. However, if in active colloquial speech the dialogue is a model of people's communication, then in addition to this, the educational dialogue is also a way of learning, including dynamics and composition in its texture. In the structure of each dialogue, there are necessarily verbal reactions of the partners of the dialogue to the content of the dialogue, statements. The requirements and conditions of interaction between partners also have an impact on the dialogue.

In educational practice, dialogue exists in two forms: student and teacher, student-student. A prolonged dialogue between one student and the teacher in the class is rare, for the reason that during the lesson there is little chance of exchanging remarks with only one student. In the event that this happens, then it happens anyway with a focus on all students in the class. Unlike everyday dialogue, in which two people can take part, in the case of a school dialogue, the participants are the teacher and all twenty or thirty students [7].

For this reason, the teacher is unable to rely on the fact that he will hear a remark-reaction to his own statement at the same time absolutely from all thirty people. The educational dialogue is a complex whole, a dialogic unity, the continuity of which is realized in the regular order and interdependence of all elements of the lesson, starting with understanding the topic of dialogue recommended by the teacher.

This comprehension also contains its own stages: explication (discovery) of the limited and broad content of the topic, emphasizing the aspect of the discussion of the topic, limiting the subject of consideration in the dialogue. The subject of discussion in the dialogue is directly related to its composition, which depends on the type and nature of the dialogue. In addition, the organization of educational dialogue implies the setting and solution of specific goals and objectives. These goals and objectives of the dialogue partners determine its specifics [8].

Speaking about the educational dialogue, it is necessary to take into account a number of organizational factors:

- not a single remark of such a dialogue should be left unanswered;
- educational dialogue involves strict time limits;
- student's inactivity is caused by the lack of his knowledge;
- the speech indicators of the educational dialogue are combined with the condition of complete answers;
- learning dialogue requires advance preparation.

Dialogue, as a creative connection between people, cannot be imagined without questions and difficulties. Unconditional unanimity between partners is un-

acceptable and disastrous for dialogue. Dialogue is also not possible in the realities of complete dependence, and in a situation of complete independence of the individual. The definition of “dialogue” in relation to learning is used in three interpretations:

1. Any scientific position is perceived in the classroom as a dialogue of various patterns, cultures, ways of perception. The analysis of scientific definitions in the range of different logics guarantees the extension of the educational dialogue to the endless difficulties of human existence, informs him of the resulting insuperability, insufficiency and at the same time essence. Directly in this sense, and it is necessary to talk about the dialogue of logicians.

2. In the process of educational dialogue, a special communication develops among the participants, during which the teacher and students not only express various aspects of ancient, medieval and modern thinking, but also and, above all, find their own personal view of the universe.

3. Educational dialogue is adequate to progressive dialogic thinking only when the conflict of cultural blocks is regularly combined with the internal dialogue of the thinker. This microdialogue takes place in the form of a separate internal speech, not identical to external speech [6].

In order for the educational task set by the teacher to be able to initiate a learning dialogue, it must be positioned as one's own point of view, a deliberate personal position that explodes the student's usual way of reasoning, stimulating the children to be creative. In order to ensure mandatory understanding of the material being explained, the teacher needs to reveal not only the meaning of the element of the content of education, but also its significance in conjunction with other constituents of social life.

Learning in this way is a type of communication, the teacher and the student act as communicants of a dialogic relationship.

The teacher must always remember that any of his students has his own position in his relationship with the teacher. The professional goal of the teacher is to help the child to see in a single problem that unique turn that confronts the individual problems and reflections of the pupil [4]. The teacher should not create obstacles in the course of redefining educational tasks, should not interfere with the organization of new tasks by students in the lesson.

Due to its versatility, dialogue in teaching is not a plot, it is not part of a lecture or a seminar. The dialogue that takes place during the entire allotted time of the lesson is “out of plot” and is independent of the current situation, but it is also prepared by it. It is impossible to perceive a reader-dialogist as some kind of information structure that works for the student.

Such a teacher is characterized by thorough attention to the problems of the student himself in the circumstances of the dialogized essence of education, in

other words, when the teacher and students enter the sphere of the boundary tasks of science, to the boundaries of the known. Equally with the student, the teacher is concerned about the problem identified in the lesson. It is as relevant to him as it is to a child. In this case, the teacher, like children, puts forward his own versions of solving the problem, puts forward his own questions, forms his own images. For students, dialogue is a feeling of equality and understanding with the interlocutor. Such equality in dialogue is by no means equality in knowledge, but equal responsibility for the formulation and result of one's question [3].

Practice confirms that if the teacher has not found or lost mutual understanding with the class team, then, as a result, there is a negative attitude towards the participant-partner in the dialogue and an intense rejection of all information coming from him. The presence of full contact between the teacher and the pupils has a beneficial effect on the dialogue, contributes to the improvement of the speech, as well as the intellectual capabilities of the students and their assimilation of the principles of human communication.

References

1. Arakelova T.L., Bezrodnykh T.V. *Theory and practice of pedagogical interactions in the modern education system: a collective monograph* / Ed. E.V. Korotaeva. Novosibirsk: CRNS, 2010. 172 P.
2. Batrakova S.N. *Pedagogical communication as a dialogue in culture* / S.N. Batrakova // *Pedagogy*. 2002. № 4.
3. Belova S.V. *Dialogue is the basis of the teaching profession*. - M., 2002.
4. Vashchenko V. *Innovation and innovative education*. // *Bulletin of Higher School*. - M., 2000, №6, 23 P.
5. Kodzhaspirova G.M., Kodzhaspirov A.Yu. *Pedagogical Dictionary*. M., 2003. 176 P.
6. Korol A.D. *Dialogue approach to the organization of learning* // *Pedagogy*. - 2007. - №9. - P.18-25.
7. Mandel B.R. *Modern pedagogical psychology. Full course. Illustrated educational for students of all forms of education* / B.R. Mandel. M.Berlin: Direct-Media, 2015. 828 P.
8. Panferov V.N. *Dialogue and communication* // *Man in the world of dialogue* / Ed. S.S. Guseva et al - SPb. - 2001. - 317 P.
9. Stankin M.I. *Psychological ways of establishing contacts between people: Textbook* Voronezh: Publishing house of SPO "MODEK", 2006. 400 P.

远程教授俄语作为外语: 动机问题

TEACHING RUSSIAN AS A FOREIGN LANGUAGE REMOTELY: PROBLEMS OF MOTIVATION

Pomigueva Ekaterina Anatolievna

*Candidate of Philological Sciences, Associate Professor
Southern Federal University*

抽象的。 本研究致力于研究俄语作为外语在线课堂学生教育动机发展的特点、动机下降的原因以及在线课堂保持注意力的可能性。

关键词: 俄语作为外语, 远程学习, 动机形成。

Abstract. *The study is devoted to the peculiarities of the development of the educational motivation of students in the online classes of Russian as a foreign language, the reasons for the drop in motivation and the possibilities of keeping attention in online classes.*

Keywords: *Russian as a foreign language, distance learning, motivation formation.*

The COVID-19 pandemic has adjusted the educational process, and lessons using remote technologies have become very popular. On the one hand, the use of distance technologies is very convenient, since the student can, without leaving his own home, in a familiar environment, without wasting time and money on travel and living in another region, get acquainted not only with the language being studied, but also with the culture of the country.

On the other hand, lessons at home distract students from the subject being studied: relatives, animals, the home atmosphere relaxes. In addition, being at the computer monitor, students are more tired than in the classroom. Another drawback of the distance format is “the lack of direct communication between students and the teacher: knowledge is transmitted mainly in written format or in the form of video recording” [Vorobeva, p. 497] or video conference, which does not always direct control over the course of the lesson. All these aspects do not at all contribute to the growth of students’ interest in classes and increase their motivation.

To form the motivation of students in the study of Russian as a foreign language, the teacher needs to create conditions that activate cognitive activity that satisfies the need for effective language acquisition.

These conditions include:

1. “the use of interactive teaching methods,
2. the involvement of linguistic and cultural material;
3. the use of interdisciplinary connections,
4. the creation of a favorable atmosphere of communication,
5. learning by example” [Makeenkova T.V., Senchenkova E.V., p. 205].

Among the Russian-language electronic linguistic resources, we can distinguish:

1) reference resources that provide systematized information on the Russian language (Dal’s Dictionary, Etymology and History of Russian Words, Dictionary of Youth Slang, Russian Thesaurus);

2) information resources, in which information of a cognitive and developmental orientation is thematically presented (Russian writing, Handwritten monuments of Ancient Russia, the Common Slavic linguistic atlas, Analysis of surnames, the Art of metaphor [Kindrya, p.20];

3) educational resources that allow you to optimize the process of teaching the Russian language, have a cognitive and developing orientation (Do you know the word? Gramota.ru, World of the Russian word, Russian letter).

Of course, with the expansion of the possibilities of information technologies, the forms of conducting Russian as a foreign language classes should also be improved. Today, there are many Internet resources (for example, interactive worksheets, game tasks QUIZLET, FLIPPITY, etc., interactive tests, quizzes, QUIZZZ, KAHOOT surveys, interactive presentations, etc.), the use of which also contributes to increasing interest in the subject being studied, and their active cognitive activity, and increase the productivity of the lesson.

These Internet resources allow you to compile various exercises on a web page: you can combine texts and audio texts, animations, videos, phonetic tasks, grammar exercises. Students always learn new material with great interest and remember what they have already learned, if the information is presented in the format of an interactive presentation, which can include not only pictures, videos, sounds, but also various interactive game tests and tasks that allow you to check the degree of assimilation of the material.

In shaping the motivation of foreign students, the involvement of linguistic and cultural material also helps. Students are happy to get acquainted with Russian traditions and customs, features of life and culture. The principle of novelty plays a special role in this, which teachers and methodologists of Russian as a foreign language consider one of the main motivational factors. By studying the Russian language, students learn the cultural values of Russia.

Linguistic and cultural information is woven into the plot of the lesson:

- these can be small online lectures about culture, national cuisine, literature, music, painting, cinema, traditions and history of celebrating the New Year, Christmas, Maslenitsa, etc. in Russia;

- online quests and quizzes that allow you to add a competitive element to the lesson; virtual tours that allow you to travel to different cities in real time and get acquainted with cultural monuments (for example, after a text about Moscow or St. Petersburg, students are happy to attend an online tour of these cities and can see with their own eyes what read),

- broadcasting movies and cartoons reflecting Russian realities and allowing you to hear the real speech of native speakers (in this case, not only self-motivation is formed if the film is interesting in itself (often having seen a fragment of the film in the lesson, the guys want to watch it in its entirety after school hours), and practical motivation, the formation of which is associated with the effect of pleasure and satisfaction from the fact that students can understand sounding Russian speech. This inspires confidence in their own abilities and helps to create a desire to further learn the language.

- the study of Russian songs, which help not only to form auditory and pronunciation skills, but also to get acquainted with vocabulary in context and repeat grammatical constructions.

It is very important that teaching Russian as a foreign language at the university should be based on the future specialty, familiarity with terminology, lexical and grammatical structures will certainly help in mastering the future profession.

In addition, a favorable atmosphere in the classroom, positive emotions, which help to remove the communication barrier, are very important for the formation of motivation. To do this, for example, you need to keep chatting with students active, praise them so that foreign students can feel confident and free.

Learning by example also contributes to the formation of motivation. The teacher should be familiar with the topics that occupy his students, with those areas of interest that are important to foreign students. "In order to form a cognitive need among students, the teacher needs to create language situations that are as close to reality as possible. The audience should raise issues and topics that are relevant to this student audience, while considering the age, religious, social affiliation of the trainees" [Makeenkova T.V., Senchenkova E.V., p. 207].

Undoubtedly, teaching Russian as a foreign language in a remote format in different national audiences has its own characteristics associated with mental differences and the specifics of the national educational space. So, for example, in a Chinese audience, it should be considered that a teacher for Chinese students is an undeniable authority, so it is quite difficult for students to encourage a discussion with a teacher, but they are happy to complete grammar tasks in which it is necessary to insert a missing element. Chinese students can memorize large texts,

often without understanding the content, memorizing constructions rather than constructing them. In addition, during distance learning in a Chinese audience, one must remember that some Internet resources are blocked by censorship in China, which limits the ability to use individual tasks.

The development of motivation in Russian as a foreign language classes depends entirely on the teacher. Even though the current situation dictates its own conditions for teaching Russian as a foreign language, distance learning can also be exciting, productive, arousing interest among students, and, accordingly, a desire to learn Russian. The main thing is that students should not have a sense of routine.

References

1. Vorobieva S.A. *Using elements of distance learning in a modern university: pros and cons* / S.A. Vorobiev // *Innovations in the health of the nation: Sat. mater. V All-Russian scientific and practical conference with international participation. - St. Petersburg, 2017. P. 497-498*
2. Makeenkova T.V., Senchenkova E.V. *Development of motivation in the classroom in Russian as a foreign language* // *Smolensk medical almanac. 2015. №2. URL: <https://cyberleninka.ru/article/n/razvitie-motivatsii-na-zanyatiyah-po-russkomu-yazyku-kak-inostrannomu> (Date of access: 09/10/2022).*
3. Kindrya N. A. *Linguistic and cultural aspect of teaching Russian as a foreign language* // *Modern Pedagogical Education. 2017. No. 4. URL: <https://cyberleninka.ru/article/n/lingvokulturologicheskiy-aspekt-obucheniya-russkomu-yazyku-kak-inostrannomu> (date of access: 10/20/2022).*

中国俄语教师的培养：传统与创新

**PREPARATION OF RUSSIAN LANGUAGE TEACHERS IN CHINA:
TRADITIONS AND INNOVATIONS**

Xi Zhenxin

Postgraduate

Volgograd State Social-Pedagogical University

抽象的。 文章分析了中国俄语教师培训的现状。 揭示了在培训俄语教师的大学中组织教育过程的传统方法的特征。 该领域的创新过程具有特点, 表现为两种趋势 - 人性化和人道主义。

关键词: 教学法, 对外俄语教学, 中华人民共和国高等教育体系, 教育人性化, 教育人性化。

Abstract. *The article analyses the current situation in China regarding the training of Russian-speaking teachers. The features of the traditional approach of organizing the educational process in the universities that train teachers of the Russian language have been revealed. Innovative processes in this area are characterized, manifesting themselves in the form of two trends - humanization and humanitarianism.*

Keywords: *a didactic approach, teaching the Russian language as a foreign language, the system of higher education of the PRC, humanization of education, humanitarization of education.*

At present, the training of Russian language teachers is a major activity in the Chinese tertiary education system. Currently, the training of teachers of the Russian language is an important area of activity of the Higher Education system of the PRC. Although the Russian language in China is not as in demand today as English, however, against the backdrop of strengthening economic, political and cultural ties with Russia, it is very important to prepare qualified professionals of various specialties that are perfect in the Russian language. These tasks are especially relevant for the northern regions of China, as well as for large economic and cultural centers, such as, for example, Shanghai. Such specialists can only be trained by teachers who are not only proficient in Russian and understand its regularity, but also have deep knowledge in the field of pedagogy, psychology and methods of teaching Russian as a foreign language.

In the meantime, the training of Russian language teachers in China is in serious trouble. These issues can be split into two groups - organizational and didactic.

Organizational challenges include, but are not limited to:

shortage of teachers who speak not only Russian, but the language of a particular profession; it concerns special terminology in the field of economics, political science, medicine, technical specialties, etc. Such teachers would be able to train highly qualified teaching staff who, in turn, could teach Russian in higher professional training establishments;

limited number of students interested in learning Russian. This is due to many factors - from the complexity of the Russian language to the small number of schools where Russian is taught;

lack of textbooks, educational materials and other literary materials for teachers who meet modern needs;

narrow framework for practice [2];

absolutely predominant language training to the detriment of pedagogical, psychological and methodological disciplines;

lack of teaching staff in pedagogical, psychological and methodological subjects.

Amongst the didactic problems are:

the absence of a clear teaching model for the training of Russian-speaking teachers;

the inability to develop conceptual arrangements based on the achievements of modern theory and teaching methods, which could form the conceptual basis for the training of Russian-speaking teachers;

guidance on traditional (to a certain extent out-of-date) didactic and methodical approaches to the organization of Russian language teaching, psychology and pedagogical disciplines and methodical cycles;

the lack of development of the technological component of the pedagogical disciplines that constitute the basis of the professional training of teachers of the Russian language.

It should be noted that in pedagogical science and educational practice in China, the identification and solution of didactic problems are much less focused on organizational problems.

One of the main reasons for the discrepancy between the level of training of teachers of the Russian language and the currently established economic, political and socio-cultural conditions in China is the inconsistency of the didactic approaches used in the educational process of universities with the global trends in the development of pedagogical science and educational practice.

By the didactic approach we understand the system of conceptual ideas and pedagogical principles that determine the logic of the teacher's activity and the

specificity of the pedagogical means used by him. With regard to the didactic approach, it is not only about the principles and means of teaching, but also about educational principles and means, since education has, in addition to the educational function itself, also an educational function.

Currently, the traditional approach of teaching Russian and other academic disciplines prevails in Chinese universities, where Russian professors are trained. The features of the traditional approach are as follows [1, pp. 49]:

Educational goals are based on the interests of the state or (much less frequently) society, and are aimed at forming a person with a certain set of qualities that the state needs at this stage of historical development;

Within the content of education, knowledge, rather than the skills or values assigned to students, is considered the main one, so the traditional approach is always referred to as knowledge;

In the learning process, knowledge is structured in accordance with academic disciplines, each of which corresponds to a given scientific discipline. Academic disciplines are studied profoundly and fundamentally, but they are poorly connected, resulting in students not always forming a holistic picture of the world;

Interaction of the teacher and students is based on the unconditional authority of the teacher and on the need to meet all his requirements;

Verbal teaching methods prevail - the source of knowledge for students is an oral or written word. Illustrative and practical methods are of an ancillary nature and are intended to explain the information conveyed by verbal methods;

Teaching methods are of a reproductive nature and involve the accurate reproduction of the information obtained from the teacher and other sources;

Students' performance, responsibility and discipline are valued.

Language training plays a special role in the training of Russian language teachers. Good knowledge of Russian is the main component of the professional training of the teacher of this subject. The teaching of Russian as a foreign language is also dominated by the traditional didactic approach, one of the varieties of which is the grammatical and translated approach. Within the framework of this approach, emphasis is placed on the study of grammar and memorization of words, that is, traditional reproductive methods of teaching are used, requiring students to memorize large amounts of information and its accurate reproduction. At the same time, although the words that need to be memorized are divided into thematic blocks, the application of vocabulary presupposes only its correct «embedding» in certain grammatical constructions. The dialogues that make up the students are abstract and very loosely related to situations of real communication; the main thing in the dialogue is to apply a certain grammatical rule as precisely as possible. Insufficient attention is also paid to correct pronunciation and listening. Most of the exercises that students perform are written. The lead role in the learn-

ing process belongs to the teacher. Students only passively perceive the content broadcast by the teacher; they have very little opportunity to put the knowledge gained into practice. As a result, students are not interested in learning Russian, and the quality of training of specialists does not meet the requirements of society.

However, over the past two decades, Chinese pedagogical science has increasingly discussed the need for new didactic approaches, That would increase students' interest in learning Russian language and at the same time would correspond to the nature of the subject being studied, its specificity. Chinese scholars [2; 4; 5] argue that in the process of learning a foreign language, including Russian, it is necessary to form and develop the skills of listening, speaking, reading, writing and translation in Chinese students, not limited to the study of vocabulary and grammar. Only in this case will students form an idea of language as a holistic phenomenon, possessing its own laws of development and «embedded» in the culture.

Innovative approaches to the training of Russian language teachers in China are manifested in two trends - humanization and humanization. Humanization means that in the educational process the emphasis shifts from the knowledge component to the student's personality. Therefore, the goal of education is self-realization of the student, development of his abilities based on the consideration of his needs and individual characteristics. The main mechanism of learning is considered cognitive interest. Priority is given to active and interactive learning methods, including those that reproduce in the process of learning a foreign language real situations of interaction. The main focus of the learning process is not the study of grammar and vocabulary, but the formation of language skills; grammatical rules and vocabulary are considered as the means to master these skills. According to proponents of humanization, the relationship between students and the teacher should be a partnership; the role of the teacher is a mentor, assistant, consultant, tutor. Students' qualities such as activity, independence, creativity, ability to prove their point of view are valued. In the lessons of Russian as a foreign language this should be manifested, for example, in the ability to improvise during dialogue, in the ability to spontaneously build monological statements on a certain topic, use synonyms, choose the appropriate situation style of speech, etc.

Humanitarianism implies broad general education and cultural training of students. Proponents of humanitarianism argue that the professional training of teachers of the Russian language should be carried out in accordance with the world of values, culture and human relations. As for the study of the Russian language, this means that language, its patterns, features of communication in Russian in different situations, with representatives of different social groups, etc. it is impossible to understand without knowledge and deep understanding of Russian culture, History, mentality of representatives of Russian culture, values significant

for Russian man. The basic term characterizing humanitarianism is not «knowledge», but «understanding». Within the framework of this approach, value-based dialogue, reflective methods are the methods of teaching. From a technological point of view, humanizing the process of training teachers of the Russian language is extremely difficult, and the development of a methodology for the humanization of the educational process is one of the most serious and topical tasks not only for Chinese, But also for Russian pedagogical science.

From our perspective, the most productive in today's conditions is the situational approach, which creates conditions for both humanization and humanization of the process of training teachers of the Russian language. The situational approach involves the creation or introduction of an appropriate problem situation so that students feel emotionally and intellectually immersed in the situation. Such a situation should cause emotional experiences of students, expand their horizons, stimulate their thinking activity, promote a deep understanding of the content of training, form and develop the ability to solve problems [3, p. 2]. In such situations, students not only form, update and develop the skills of speaking, listening, translation, but also occurs «immersion» in the culture of the country studied language, create opportunities for understanding the language as a holistic phenomenon. The situational approach will not only increase the level of interest of students in the Russian language and its study process and thus stimulate their activity in solving educational problems, but will also create conditions for the formation of the necessary professional skills. The situational approach allows students to work actively and productively in the classroom, making learning attractive and increasing its effectiveness.

References

1. Borytko N.M. Solovtsova I.A., Baibakov A.M. *Pedagogics*. M.: Publishing Center «Academy», 2007. 496 p.
2. Lu Chungyue. *Problems and solutions in teaching Russian in the context of the project «One Belt - One Way»*. On the example of a university in Jilin province // *Teaching Russian in China*. 2019. 4(38). P.77-83 (per whale. yaz.)
3. U Hueize. *Application of multimedia teaching methods in English language learning* // *Northeast Normal University*. 2009. 2. P. 2-6 (on the whale. yaz.)
4. Juan Lay. *Situational Approach to English Teaching* // *Examinations: Weekly*. 2009. 48. P. 106-109 (per whale. yaz.)
5. Zheng Jingzhou. *Guide to Didactic Approaches in Learning*. Shanghai: Huadong Normal University, 2006. 296 p. (on whale. yaz.).

OLONKHO IN THE ARCHITECTONICS OF THE MODERN CULTURAL SPACE OF YAKUTIA

Lyapkina Tatiana Fedorovna

*Doctor of Culturology, Full Professor
Arctic State Institute of Art and Culture*

Markova Maria Markelovna

*Associate Professor
Arctic State Institute of Art and Culture*

Strekalovskaya Zoya Andreevna

*Candidate of Culturology, Head of Department
Arctic State Institute of Art and Culture*

摘要：雅库特文化空间的建筑结构复杂。这不仅是由于普遍的全球进程剥夺了当地社区的文化主权，还因为该地区强烈希望保护历史上发展并存在至今的民族成分。重点是非物质文化遗产的杰作——奥隆霍，作为建筑原则，它为它在现代文化空间中的存在开辟了新的可能性。今天的 Olonkho 不仅在文化政策和振兴共和国遗产领域是一个新理念，而且是文化本身的新经济转向，一个可以发现新资源以实现自我发展的产业 现代社会。

关键词：文化空间的建筑学，Olonkho，文化产业和实践，传统的存在形式，遗产振兴。

Abstract. *The architectonics of the cultural space of Yakutia is complexly organized. This is caused not only by general global processes that deprive the cultural sovereignty of local communities, but also by the keen desire of this region to preserve the ethnic components that have developed historically and exist to this day. The focus is on the masterpiece of intangible heritage - Olonkho, which opened up new possibilities for its existence in the modern cultural space, as an architectonic principle. Olonkho today is a new idea not only in the field of cultural policy and the revitalization of the heritage of the republic, but also a new economic turn within culture itself, an industry that makes it possible to discover new resources for the self-development of modern society.*

Keywords: *architectonics of cultural space, Olonkho, cultural industries and practices, forms of existence of tradition, heritage revitalization.*

Introduction

The spatial turn, which was first actualized in Western and then in domestic science, is, according to D. Bachmann-Medic, the brainchild of postmodernity [1]. The main *characteristics of the turn* steel: space is a social construct in which not a diachronic dimension operates, but a synchronous one, in addition, the message of the predominance of the systemic over the historical has been formed, the evolutionary understanding of development is receding into the background. In other words, today space is the production of the social. "It seems that the categories of simultaneity and parallelism have taken precedence over the categories of development and progress" [1; p.340]. In this regard, it is interesting to see how this spatial reality is realized in local communities.

Today, interest in space and its various forms reveals a variety of borders, walls, fences, thresholds, marked territories, security systems and checkpoints, virtual borders, specialized zones, protected areas and controlled areas [1; p.342]. However, we will be interested in other boundaries, more complex - cultural, mental boundaries.

The purpose of the study is to analyze the architectonics of the cultural space and to identify the position of Olonkho in the integral system of modern culture of Yakutia.

Materials and research methods.

In this study, the *architectonics of cultural space* is used as the main concept, since it simultaneously reconciles the positions of the temporal and spatial phenomenon of the culture of modern Yakutia. There is a special metaphor in it, it emphasizes the possibility of considering the "alignment" of special relations of the whole and the detailed, the main and the secondary, the hierarchy of the elements of culture, building relationships between the center and the periphery of the cultural space [2; 3]. Architectonicity, as one of the central qualities of culture, allows you to perceive the object in its entirety, and its elements in subordination to each other.

Olonkho, which occupies one of the central positions in the architectonics of the cultural space of Yakutia, is a masterpiece of the oral and intangible cultural heritage of mankind (2005). In the conditions of the modern economy, it has revealed itself as a resource for the new development of the cultural space of the region. Therefore, the main part of the policy of the Republic of Sakha (Yakutia) is to solve the problems of heritage revitalization in practices and cultural industries [5].

Defining the modern cultural space of Yakutia with the help of this metaphor, the complex organization of the elements of this cultural space attracts attention. In the center of it, the main tradition of the Yakut culture, Olonkho, shows its architectonic qualities. Around the Olonkho, mechanisms were formed to translate

the Olonkho into different areas of everyday practices, which resulted in the well-formed socio-cultural institutions. Among them: the Olonkho research institute and its activities not only in the form of scientific publications of monographs and articles, but also international and Russian scientific and practical conferences; the Institute of National Schools, which developed original educational programs - learning through the texts and meanings of Olonkho; republican center of the heroic epic Olonkho, organized by the Ministry of Culture and Spiritual Development of the Republic of Sakha (Yakutia), the National Committee for UNESCO, the House of Friendship of Peoples - RCC named after Kulakovsky, the theater "Olonkho and the House "Archy". In addition, Olonkho houses, public organizations and foundations joined this movement aimed at spreading the Olonkho culture. Olonkho is in the center of art exhibitions, images of Olonkho are used in computer games, the first cartoons based on Olonkho plots appeared. All this made the promotion of Olonkho quite successful in modern visual culture. Its capabilities create the effect of added reality with the help of new technologies and digitalization of texts in creative industries: audiovisual exhibition "Revived Olonkho Legends" (3D Mapping) (2019); collaboration of creativity "Music + Fine Arts + Olonkho" (2019, 2022); visualization of plot graphics; action; computer game (2005) All these forms of Olonkho revitalization exist in the conditions of visual culture.

So, briefly outlining the architectonics of the cultural space, let's pay attention to the most dynamic institutions, the ongoing revitalization processes of Olonkho. Among such institutions is - **the festival movement**. It should immediately be noted that it is the most mobile phenomenon of mass culture. It was the festival movement that actualized some forms of heritage revitalization: festivals of young, young and adult performers of the epic; competition "Battle in the style of Olonkho" using modern forms of work with youth - stand-up, KVN, rap battle; the festival has become a space for global epic artistic communication – an international dialogue of storytellers, a process of integrating epic artistic communication. In addition, the festival, which is very important in the context of our study, is able to demonstrate the features of the regional artistic tradition of storytelling. The festival can be considered as a model for the implementation of the art project of storytelling in various regions of Yakutia. An analysis of the dynamics of the development of the festival movement showed a high degree of involvement of young people in the tradition, through modern forms of mediation. The activities of folklore groups, the formation of an epic audience of Olonkho lovers, the preservation of institutions, the generation of a new youth subculture of Olonkho epic performers - all this is coordinated by the technologies of socio-cultural mediation, collaboration, and revival design.

Theater "Olonkho" (2008), which, according to the organizer of the theater A.S. Borisov, is an ambassador of the Yakut culture on the one hand, and an in-

strument for the revival of the unique phenomenon of the Yakut people, is also an institutional unit of the architectonics of the cultural space of Yakutia [6]. The study of the theater and its activities M.M. Markova, is reduced to the idea of the natural theatrical nature of Olonkho, the content of which is quite consistent with the theatrical action [4, p.70]. The particular interest of this position translates into a comparative analysis of the theatrical traditions of the west and east. Studying the signs of theatricality, a number of very similar characteristics are revealed - the game, the momentary, the presence of the viewer, the synthesis of different types of art. But at the same time, there are other distinctive features where the Eastern theatrical tradition does not coincide with the Western one. Precisely according to the theatrical and ideological characteristics.

In addition, we believe that a kind of evolution of the Olonkho itself makes its movement from an individual to a collective form of theatrical action more visually and textually noticeable. This tradition gives rise to the epic theater, to which the Eastern theater gravitates, while the Western tradition is closer to the tradition of dramatic theater. The epic nature of the theater, including the Olonkho theater, does not immerse the viewer in the emotional, dramatic experiences of events on the stage, but tends to orient the audience to think critically, express judgments, and, in the end, act. He unfolds the fact from different points of view, non-linearly. While the drama theater is aimed at emotional involvement and entertainment.

It seems important to us that the “Olonkho” theater is included in the process of multiplication of tradition, as well as the festival movement. The theater is a mechanism for the translation of very important cultural meanings of Olonkho into the modern society of Yakutia.

Conclusions:

So, the complexly organized architectonics of the cultural space of Yakutia is implemented in various forms and types of institutions. The study shows that the core of the cultural space of Yakutia is Olonkho. This approach allows us to see the phenomenon in its complexity and in the subordination of elements to each other. The general idea of the activities of institutions is to use Olonkho in everyday practices. All these processes show the possibility of translating the text from the once sacred practices into everyday ones, which greatly expands the possibilities of revitalizing the heritage in general and the Olonkho in particular. In addition, these practices form the possibility of converting cultural heritage into a new form for the region - creative industries. The process of multiplication (reproduction) of Olonkho in various institutions and forms allows not only to architectonically integrate the space of culture, but also to create the possibility of its expansion. In addition to the central one, the study briefly presents two elements in the architectonics of the cultural space of Yakutia - the Olonkho festival movement and the Olonkho theater.

References

1. *Bachmann-Medic D. Cultural turns. New landmarks in the sciences of culture. M.: New Literary Review, 2017. 504 P.;*
2. *Lyapkina T.F. Architectonics of the cultural space of Eastern Siberia. Late XVII - early XX centuries SPb.: Info-da, 2006. 386 P.;*
3. *Lyapkina T.F. Cultural Space as a Research Metaphor for Regional Culturology // Regional Studies – 2016. P.32-41;*
4. *Markova M.M. Origins of the Yakut epic theater// Culture and civilization. №1A, 2022. P.69-81;*
5. *Strekalovskaya Z.A. Modern cultural practices of Olonkho conservation. Abstract diss. for a scientific deg. cand. culturology. – Chita, 2020. – 24 P.*
6. *Official website of the theater «Olonkho» [Electronic resource]// URL: <https://Olonkhotheater.ru/about-the-theatre/history/> [Appeal date 01.10.2022]*

低龄学童对广告影响的心理抵抗形成过程的建模
**MODELING OF THE PROCESS OF FORMATION
OF PSYCHOLOGICAL RESISTANCE OF YOUNGER
SCHOOLCHILDREN TO THE INFLUENCE OF ADVERTISING**

Gribina Lyudmila Vladislavna

*Candidate of Pedagogic Sciences, Associate Professor
Adyghe State University, Maykop c.*

Petrova Nina Vasilievna

*Candidate of Pedagogic Sciences, Associate Professor
Adyghe State University, Maykop c.*

Yurina Alla Anatolyevna

*Candidate of Philological Sciences, Associate Professor
Adyghe State University, Maykop c.*

抽象的。本文考察了广告对低龄学生产生负面影响的因素。提出了一个低年级学童对电视广告影响形成抗拒过程的模型，在结构上由以下组成部分表示：目的、组织原则、一组必要的心理条件、形成过程的主要方向。阻力，性能标准列表，预期结果。

关键词：广告、广告操纵、消费主义、心理稳定性、心理抗拒形成模式对电视广告的影响。

Abstract. *The article examines the factors of the negative impact of advertising on younger students. A model of the process of formation of resistance of younger schoolchildren to the influence of television advertising is proposed, structurally represented by the following components: purpose, principles of organization, a set of necessary psychological conditions, the main directions of the process of formation of resistance, a list of performance criteria, expected results.*

Keywords: *advertising, advertising manipulation, consumerism, psychological stability, a model for the formation of psychological resistance to the influence of television advertising.*

Advertising, as a powerful means of influencing the mass consciousness, in modern socio-cultural conditions, performs the function of one of the sources of information about the goods and services provided. By imposing worldview ideas and invading the sphere of life values, it contributes to the formation of a sus-

tainable personal quality - consumerism. Primary schoolchildren are exposed to a particularly noticeable advertising impact, whose vital space flows not only in the field of educational activity, but also outside it and falls under the influence of many social factors, in particular advertising [2, 3, 5, 6]. Acting through the psychological mechanisms of imitation, suggestion and identification, advertising acts as a mesofactor in the socialization of younger students.

Theoretical analysis of the problem under study allows us to state that there is a fairly wide range of interdisciplinary studies of the phenomenon of advertising and its impact on a person. In the psychology of advertising, the problem of the influence of an advertising message on the human psyche is actively studied (N.N. Avdeyeva, L.P. Kazakova, F. Kotler, D.A. Leontiev, R.I. Mokshantsev, E.E. Pronina, N.A. Fominykh and others). The problem of the influence of advertising on the motivational sphere of the psyche of a younger student is presented in the works of N.N. Avdeyeva, L.I. Bozhovich, A.I. Dontsova, V.S. Mukhina, E.E. Sapogova, N.A. Fominykh, D.B. Elkonina and others. The content of the process of formation of the psychological stability of younger schoolchildren to the influence of television advertising is the subject of Kh.M. Alieva, A.I. Dontsova, M.I. Dyachenko, B.A. Sosnovsky, V.D. Shadrikov.

The works of these authors formed the theoretical basis of our study, the main purpose of which is to develop and test a model of the process of formation of resistance to the influence of television advertising on the motivational sphere of a younger student.

The object of the study was the emotional and motivational spheres of children of primary school age, and the subject of the study was the process of formation of the stability of the motivational and emotional spheres of younger schoolchildren to the effects of advertising.

The study tested the validity of the hypothesis:

- 1) television advertising arouses interest among younger students and determines changes in their motivational sphere due to its attractiveness;
- 2) an experimental model of the process of formation of the psychological resistance of younger schoolchildren to the influence of television advertising can neutralize its negative impact on the child.

The theoretical analysis of the research problem allowed us to identify four types of advertising effects on the human psyche:

- cognitive. The mechanism of influence is such mental processes as sensation, perception, attention, associative thinking, memory. The result is the receipt of new information;
- affective. Causes an emotional attitude that encourages desires, experiences;
- regulatory. Stimulates for specific behavioral actions aimed at meeting needs as a result of active interaction with advertising;

- communicative. Encourages language resources used in advertising to interact with all previous human experience in order to provide a communicative impact on him [4].

The process of psychological impact of advertising on the human psyche is inevitably represented by the following components: informing (reporting beneficial facts); persuasion (impact by purposeful argumentation); motivation (application of slogans, mottos, appeals acting on the psyche); suggestion (targeted emphasis on feelings and emotions); neurolinguistics programming (creating a situation of conjecture, subconscious striving for semantic constructions according to expectations). The combination of these components ensures the influence of advertising on the human psyche at the conscious and unconscious levels [4]. A person who has the ability to maintain the optimal functioning of the psyche, that is, a psychologically stable person, is capable of resisting the negative influence of advertising.

In domestic psychology, an integral description of the psychological stability of a person is offered in three aspects: 1) resistance. It is considered as the ability of a person to believe in his/her resources in situations of frustration and to resist difficulties; 2) balance. It is understood as a harmonious balance between emotions, thoughts and actions of a person, as the ability to rationally accept everything that happens; 3) resistance. It is interpreted as an activated mechanism of opposition of the personality to the negative influences of the environment [2].

The psyche of a child of primary school age is characterized by a low level of development of stamina, balance, and resistance due to its dynamism, increased emotionality and suggestibility. Therefore, it can be stated that psychological resistance to the negative influence of the environment in primary school age is in its infancy.

In our study, under the negative influence of the environment, we consider advertising. This influence is determined by the age characteristics of younger schoolchildren. Among them, the most significant are: weak development of critical thinking, high dynamism and stereotyping of behavior, increased emotional sensitivity and suggestibility of the motivational sphere. These age-related features are intensified under the influence of the child's pronounced need for research activity. The younger schoolchild seeks to actively master the "forbidden" space, the knowledge of the world of adults. This is his/her openness to various social phenomena, including advertising [1, 3, 5, 6].

The study of the theoretical foundations of the research problem made it possible to develop a model for the formation of the psychological resistance of younger students to the influence of television advertising (Figure 1).

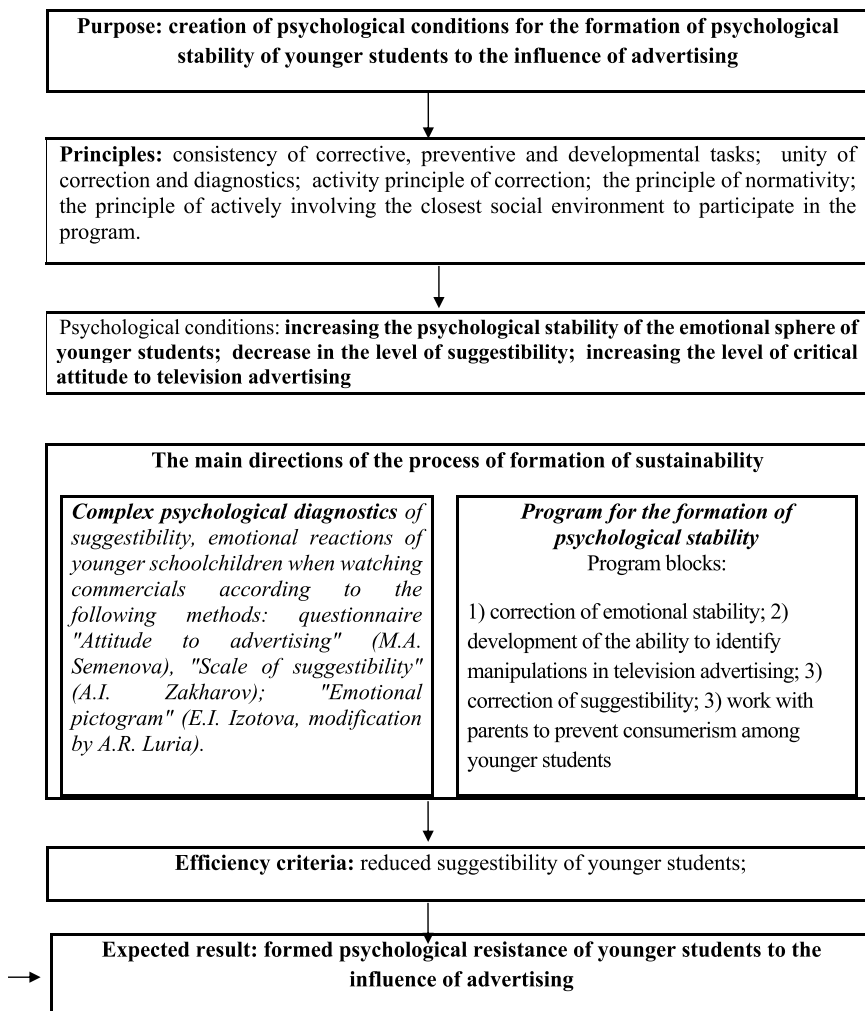


Figure 1. Model of the process of formation of resistance of younger schoolchildren to the influence of advertising

The process of forming the psychological resistance of younger schoolchildren to the influence of advertising is structurally represented by two directions. The first direction is diagnostic. Research work in the context of this area was carried out using the following methods:

1) the questionnaire “Attitude towards advertising” (M.A. Semenova) is aimed at identifying children’s ideas about the purpose of advertising; the degree of their confidence in advertising; study of the preferred attitude of children to a particular commercial, the impact of advertising on consumer preferences of children, children’s reactions to parents’ refusal to purchase goods;

2) the “Suggestibility Scale” method (A.I. Zakharov) allows diagnosing the emotional involvement of younger students when watching television advertising; imitation by younger students of external actions that are shown in television commercials; visual impact of the roller; influence of the text of television advertising; the impact of the plot and content of television advertising;

3) the “Emotional pictogram” method (E.I. Izotova, modified by A.R. Luria) is informative for studying the emotional state of younger students before watching television commercials and after it.

The second direction is represented by the program of formation of psychological resistance of younger schoolchildren to the negative impact of advertising. The program is designed for 12 lessons. The frequency of classes is 2 times a week. The duration of the classes at the initial stage was 25-35 minutes, and at the final stage - 40 minutes.

Structurally, the program is represented by four blocks.

The first block of the program contains classes, the main purpose of which is the development of emotional discharge skills, increasing the stability of emotional processes. At this stage, psycho-gymnastic exercises are used, which are aimed at developing the skills to overcome emotional arousal, establish contact, relieve tension, etc.

The second block is aimed at developing skills to identify manipulations in advertising. Its purpose is the formation of arbitrary behavior and a selective attitude towards the advertised goods. Classes are held mainly in the form of a game.

The third block involves a cycle of classes to update cognitive motives, reduce the importance of negative motives (hedonistic, playful, prestige motive), and form the stability of the hierarchy of motives. The purpose of this block is to form the interests and desires of a younger student.

The fourth block involves working with parents. Its goal is to prevent consumerism among younger students.

The results of the model implementation showed the following. At the stage of the control experiment, the attitude of younger schoolchildren to advertising became more conscious and critical: 8% of children trust advertising, and 59% expressed distrust. Most of the children showed independence from advertising. Only 13% of children “swayed” by advertising. It is noteworthy that the answers of almost all parents coincide with the answers of children. The average suggestibility score ($M_x = \frac{(\sum x)}{n}$) obtained by us at the stage of the ascertaining experiment was 0.9 points, at the control stage -0.4 points. A comparison of these values indicates a decrease in the suggestibility of younger students.

As a result of the assessment by younger students of their emotional state after watching television commercials, the following data were obtained: 27% of children experience joy, interest - 21%, surprise - 13.6%, shame - 6.8%, fear - 3.4%, anger - 1.7% of children.

Spearman's rank correlation was calculated to determine the connection between the signs of an emotional attitude to advertising among younger schoolchildren at the ascertaining and control stages of the experiment. The obtained coefficient ($0.4 \leq 0.6 \leq 0.7$) indicates the presence of a moderate relationship between the signs of an emotional attitude towards advertising of younger students at the ascertaining and control stages of the experiment.

Conclusions from the results of the study

The experimental model contributed to the formation of the psychological resistance of younger students to the influence of advertising, which manifests itself:

- in preventing deformation of the motivational sphere through awareness of one's vital and spiritual needs and motives;
- in the development of skills to regulate their emotional sphere;
- in the development of the ability to identify a variety of manipulation techniques in commercials;
- in the formation of a critical attitude to advertising.

References

1. Avdeyeva, N.N. *Psychological impact of TV advertising on children* / N.N. Avdeyeva, N.A. Fomins. – LLC Publishing House Rech, 2004. – 265p.
2. Dontsov, D.A. *Children's image as a factor in advertising impact: Abstract of the thesis. ... Cand. of Psychol. Sciences* / D.A. Dontsov. –M., 2001. 26p.
3. Levitskaya, A.A. *Your child and advertising* / A.A. Levitskaya. –M.: LPO "Information for everyone", 2011. 98 p.
4. Plessy, D. *Psychology of advertising influence. How to effectively influence consumers* / D. Plessy. –St. Petersburg: Peter, 2007.–272 p.
5. Semenova, M. A. *Features of the influence of television advertising on children* / M. A. Semenova. – Text: direct // *Young scientist*. — 2018. – No. 13 (199). – P. 284-286. — URL: <https://moluch.ru/archive/199/49044/> (date of access: 12.10.2022).
6. Marinova T.Yu. *Features of the impact of television advertising on children of primary school age: Materials of the International Scientific and Practical Conference of the Russian State Pedagogical University. A. I. Herzen. St. Petersburg, April 22–23, 2019* / T.Yu. Marinova, A.Yu. Fedyaev. Under the general and scientific editorship of V.L. Sitnikov. – St. Petersburg, 2019 – 555-558 p.

中亚地区的中国因素: 对安全领域的影响

THE CHINESE FACTOR IN THE CENTRAL ASIAN REGION: THE IMPACT ON THE SECURITY SPHERE

Toropygin Andrey Vladimirovich

Doctor of Political Sciences

*Leningrad Communist University of The Russian Presidential Academy
of National Economy and Public Administration, St. Petersburg,
Russian Federation*

抽象的。中国是中亚重要的非区域性参与者。最近,它对本地区各国的影响非常显着。随着经济的发展,安全领域的中国因素也在增加。阿富汗塔利班的上台(“塔利班”——俄罗斯禁止的运动)造成了对该地区安全产生负面影响的新局面。中国在上合组织框架内的活动,特别是为地区国家打造“5+中国”互动格局,推动“一带一路”建设,使中国成为地区重要的安全因素。

关键词,安全,中亚国家,上合组织,集体安全条约组织,阿富汗,俄罗斯,安全因素。

Abstract. *PRC is a significant non-regional player in Central Asia. Recently, its influence on the countries of the region is very significant. Along with the economy, the Chinese factor is also increasing in the field of security. The coming to power of the Taliban in Afghanistan (“Taliban” - a movement banned in Russia) created a new situation that negatively affected security in the region. The activities of the PRC within the framework of the SCO, and especially the creation of the 5+China interaction format for the countries of the region to promote the One Belt, One Road project, have made China an important security factor in the region.*

Keywords: *Security, Central Asian countries, SCO, CSTO, Afghanistan, Russia, security factor.*

Central Asia is a rapidly developing and resource-rich sub-region of Asia. But despite the favorable geopolitical position between Europe and the new industrial countries of Asia, China and India, in a political and social sense, they cannot be called stable. Drug trafficking, radical Islamism, border disputes, social problems and occasional political crises continue to be significant security challenges. Neighborhood with Afghanistan and China’s Xinjiang Uighur region add to this list the constant threat of the most diverse manifestations of terrorism.

Since the beginning of the 90s of the last century, the name Central Asia and Kazakhstan have been replaced by a definition that includes all the new independent states formed after the collapse of the USSR. Sometimes this included Afghanistan and Mongolia. Despite the fact that the existence of such a region was not questioned, the UN even tried to establish a UN Economic Commission for this region (UN Special Program for the Economies of Central Asia (SPECAC)), its own regional development concept, the countries have just begun to develop. Therefore, historically, Russia has played the largest role in ensuring the security of the region. In the field of security, the activities of international organizations such as the CIS and CSTO are largely what Russia proposes or agrees with.

The most important non-regional players are the USA, China, Turkey, and the EU. Of the multilateral structures in which non-regional states participate, the most significant is the Shanghai Cooperation Organization. The transfer (2004) of the Regional Antiterrorist Center from Bishkek to Tashkent strengthened the participation of Uzbekistan in it and contributed to the closure of an important direction of the terrorist threat from Afghanistan. Finally, the concept of “three evils” and countering terrorism, separatism and religious extremism is supported by all member countries. On the other hand, the composition of the SCO member states is not conducive to addressing the issue of security; the views on it are different among the countries that are members of the Organization. Not to mention serious conflict situations among members.

The US was in Afghanistan from 2011 to 2021. The departure of the US troops, although quite predictable, turned out to be decisive for changing the political structure of the state. Power, the second time passed to the Taliban; to the Taliban, banned in Russia. The Taliban is recognized as terrorist in many countries of the world, which was supported by the UN. The emergence of a terrorist government has certainly created a new situation in Central Asia, reducing the security of the region.

Multilateral negotiations became a formal response to the new situation. In Dushanbe, the capital of Tajikistan, consecutive meetings of the SCO, CSTO and a joint meeting of the heads of member states of both organizations were held. Afghanistan was not represented at the SCO summit. The leaders of the countries agreed that the organizations are faced with the urgent task of developing and implementing an agreed line, taking into account the situation that has arisen in the region caused by the US withdrawal from Afghanistan. Relevant documents were adopted, in particular, they discussed issues of cooperation between the two organizations to build coordination of actions, taking into account the specifics and powers of SCO and CSTO. But in general, the meetings were devoted to current issues. They passed in the usual business environment. Hopes were expressed that the new Afghan authorities were fulfilling their own promises of peace, normalization of public life and security for all¹.

¹ Electronic resource: [Kremlin.ru/events/president/news/66706](https://kremlin.ru/events/president/news/66706)

We can say that in fact this is one of the first cases when SCO was really considered as an essential element of security. Until that time, SCO was in the shadow of CSTO and it is quite clear that in this case, when talking about SCO, PRC is meant.

Always, to a greater extent, attention was paid to SCO, if not to an economic structure, then they emphasized its capabilities as an important negotiating platform for Asian countries.

At the same time, SCO is one of the few security-related entities that does not include the US, and has facilitated China's military presence in the region; SCO was a tool that allowed China to settle its territorial issues with Russia and the countries of the region; it provided a good basis for enhancing interoperability and coordination with the Russian military.

Many, especially Western experts, believe that SCO was the first and main multilateral structure used by the People's Liberation Army of China (PLA) for external military training [4]. Indeed, in the period from 2002 to 2016, there were almost 40 joint exercises in the region [4]. China's first exercises with Russian counterparts were held back in 2005. These were the first exercises of the Peace-keeping Mission. There are also exercises "Peace Mission SCO"; "which SCO conducts on a semi-regular basis" [4].

A major exercise was held with Tajikistan in 2016 involving ten thousand troops near the border with Afghanistan [4]. From a security point of view, this obviously benefits both all the Central Asian countries and the PRC. It helps China solve its own security problems; the area is located near the troubled Xinjiang Uygur Autonomous Region.

The opinion that the SCO was just the structure that gave the PLA invaluable experience in obtaining advanced combat operations, testing military equipment and actually operating outside the national territory is very popular in the West [4].

In Central Asia, there is a proverb - "only the one who, at least slowly, but goes on, will overcome the road". Unfortunately, this did not happen in Afghanistan. This is if we talk about the process of modernization of states. The countries of Central Asia have become sovereign modern states since the nineties of the last century. But they retained their traditional desire for peace and good-neighborly relations. All the years, from the end of the 1990s to the beginning of the 2000s, the leaders of Central Asia tried to establish pragmatic relations with the Taliban. But at the same time, they did not forget another folk wisdom - about a high and strong fence.

Experts say that one hundred and fifty kilometers of the Uzbek-Afghan border - two rows of live barbed wire, a mine and a road under surveillance. The transition between the countries is the Termez-Hairaton bridge. With Turkmenistan, the border is 800 kilometers across the desert. The border is complex, but covered by

heavy military equipment. The Tajik-Afghan border is the longest, about 1400 km and the most difficult, river and mountains. But the forces of the Russian Federation are involved in its protection [2].

Obviously, the main difficulty is that there are a lot of Tajiks in Afghanistan (according to E. Rahmon, 46% of the population; researchers say about 20%²). Yes, and not in quantity, the difficulty is, there are also a lot of Uzbeks, but the government of Uzbekistan considers them as citizens of Afghanistan, does not consider them representatives of the Uzbek diaspora. The position of the head of Tajikistan is different - he is "the guardian and patron of all Tajiks of the world" [3]. This position was formed during the civil war. Then she bore fruit. Now it is not very clear whether it will bring benefits. This very difficult question has no obvious answer. And countries act differently. For example, in Kazakhstan there is no concept of "national minority"; "Russian diaspora" - contrary to the true state of affairs, Russians are part of our people, says President Tokayev³.

All Central Asian countries are trying, as before, to establish pragmatic relations with Afghanistan. Here and the development of trade, and most importantly, rail transport. But over the past year, life has not become easier for the population of the country. There are practically no jobs. And this is against the background of limiting the share of working women introduced by the Taliban from 22% to 15%⁴. Many families have lost any income at all. But the main thing is that people still continue to die. From August to the end of June 2022, more than 700 people died in Afghanistan and more than 1400 were injured, according to the UN⁵.

The Afghan authorities are hoping for China, which intends to invest heavily, primarily in mining, believing that participation in the "Belt and Road" (BaR) project is a pass to world markets. But it is not yet clear how such a mechanism will operate, if at all.

There is such a mechanism for interaction with the countries of Central Asia.

In May 2021, a meeting of the foreign ministers of the Central Asian countries and the PRC was held in Xi'an (China). The result of the meeting was the establishment of the format - "5 + 1", the countries of Central Asia - China. This was the result of interaction between the heads of the Foreign Ministries of the six countries. The meetings of the heads of foreign affairs agencies made it possible to agree on a common goal - to promote mutually beneficial cooperation in modern conditions. The agreed format made it possible to proceed to the formation of mechanisms, which were:

² Electronic resource: "We all go into darkness": how is Afghanistan doing a year after the arrival of the Taliban? <https://www.bbc.com/russian/features-62550947>

³ Electronic resource: <https://informburo.kz/novosti/tokayev-vyrazhenie-russkaya-diaspora-protivorechit-istinnomu-polozheniyu-veshchey-russkie-chast>

⁴ Electronic resource: "We all go into darkness": how is Afghanistan doing a year after the arrival of the Taliban? <https://www.bbc.com/russian/features-62550947>

⁵ Ibid

- at the level of deputy ministers of foreign affairs, a body has been created to coordinate work on preparing meetings and monitoring the implementation of their results;

- each foreign ministry will have a contact mechanism, a kind of headquarters.

- creation of a mechanism that will contribute to maintaining a regular dialogue at the academic and expert levels;

- great attention will be paid to strengthening cooperation in the media;

- priority areas of cooperation have been identified. At this stage, there are 12, but their number may be updated as the situation develops.

- on the development and adoption of a comprehensive Joint Action Plan focused on achieving practical results⁶.

The format, through its mechanisms, is designed to increase the return on the participation of countries in promoting the BaR initiative in increasing transport potential and developing trade, solving social problems, etc.

Such formats and mechanisms are known. These are the “17+1” format, countries of Central and Eastern Europe and “5+1” countries of Northern Europe and China.

This can be assessed in different ways, but this is the institutionalization of interaction with BaR.

There are different views regarding the military vector of BaR. Apparently, those who spoke about its presence correctly assess the situation.

In other words, we can expect an increase in the presence of both the armed forces (there are armed people's police forces PRC in the territories of the Central Asian countries) and the *unarmed forces* - the personnel of private military campaigns / enterprises (PMCs). Already in 2013, 4000 of them were registered from 4.3 million employees. And their number is growing exponentially.

So, the Chinese Academy of Social Sciences in 2020 noted that 84% of PRC investments in BaR are in countries with medium and high risk. To this should be added the rather frequent abductions of Chinese workers and employees for various purposes.

But most importantly, this is a new course of the Chinese leadership in understanding the activities of the modern armed forces of the state.

The watershed here was the counter-terrorism PRC Act of 2015, art. 71 of which speaks of the possibility of using the army and armed police outside the country.

So far, three options / implementation of such activities are known:

- naval base in Djibouti;

- multilateral force model “Mekong model”;

- humanitarian evacuation model.

⁶ Electronic resource: <https://turkmenportal.com/blog/38734/sovместnoe-zayavlenie-po-itogam-konsultativnoi-vstrechi-glav-gosudarstv-centralnoi-azii>

New in this series is the Code of Regulations on Non-Military Actions of the People's Liberation Army of China (PLAC) June 2022⁷. Rescue operations, humanitarian aid, peacekeeping operations, etc.

The People's Republic of China behaves very prudently, not interfering in conflicts in the Central Asian region (including in Kazakhstan in 2022). But, for example, in Kyrgyzstan, there are already Chinese security companies (in China there are no PMCs in the legislation)⁸.

In other words, China has every opportunity to play a more significant role in ensuring security in Central Asia. And this is a very positive thing.

Secretary of the Russian Security Council N. Patrushev, opening the annual meeting of the secretaries of the Security Councils of the CIS countries (November 2021), said that an unprecedentedly difficult situation is developing in Afghanistan - both in military-political and socio-economic terms⁹.

Since then, the situation has only worsened. Experts directly say that the country is on the rocks of civil war [1]. And this should be taken seriously.

While the Taliban held back the production of maca, today it appears to be virtually the country's only resource amid US reluctance to unblock Afghan bank accounts. The beginning of a civil war and the involvement of neighboring states into it seem quite real.

Thus, the influence of the Chinese factor on the security of the Central Asian countries will increase, while Russia, for an objective reason at the current stage, will decrease.

References

1. *A new civil war could start in Afghanistan — orientalist* <https://eadaily.com/ru/news/2022/08/15/v-afganistane-mozhet-nachatsya-novaya-grazhdanskaya-voyna-vostokoved>
2. *Umarov T. Carried away by the "Taliban". Will the regimes of Central Asia fall. Moscow Carnegie Center* <https://carnegie.ru/commentary/experts/1487>
3. *Umarov T. One against the Taliban. Why Tajikistan is in conflict with the new authorities of Afghanistan. Moscow Carnegie Center.* <https://carnegie.ru/commentary/85612>
4. *Securing the belt and road: initiative China's Evolving Military Engagement Along the Silk Roads* https://www.nbr.org/wp-content/uploads/pdfs/publications/sr80_securing_the_belt_and_road_sep2019.pdf

⁷ Electronic resource: Xi Jinping signed a set of regulations on non-military operations of the Chinese army <https://life.ru/p/1501847>

⁸ Electronic resource: <https://politic.kz/novosti/11422-kitaiskie-voennye-kompanii-edut-v-tsentrlnuii-aziiu-otvet-eksperta>

⁹ Electronic resource: <https://rg.ru/2021/11/17/patrushev-afganistan-na-poroge-novoj-grazhdanskoj-vojny-obnischaniia-i-goloda.html>

7岁以上儿童急性重度合并颅脑损伤患者每搏血量的昼夜节律
**CIRCADIAN RHYTHM OF STROKE VOLUME OF BLOOD IN
ACUTE SEVERE CONCOMITANT TRAUMATIC BRAIN INJURY
IN CHILDREN OLDER THAN SEVEN YEARS**

Muhitdinova Hura Nuritdinovna

*Doctor of Medical Sciences, Full Professor
Center for the Development of Professional Qualifications
of Medical Workers*

Alauatdinova Gulhan Inyatdinovna

*Department assistant
Center for the Development of Professional Qualifications
of Medical Workers*

抽象的。在第 3 组儿童的第一天观察到每搏输出量最明显的不稳定性,第 1 组和第 2 组 - 15 毫升的 SV 每日波动幅度为 22 毫升。在 SCTBI 的第 1 天发现了一种多动型的血流动力学应激反应。第 2 组患者每搏输出量昼夜节律中值的最显着增加是由于颅外损伤的严重程度占优势。SV 与体温呈正相关,表明全身炎症反应对增加第二组儿童的心输出量具有主导作用。在第 3 组中发现了 SV 昼夜节律最长和最明显的倒置。

关键词: 昼夜节律, 每搏输出量, 严重合并颅脑损伤, 儿童。

Abstract. *The most pronounced instability of stroke volume was observed on the first day in children of group 3 with an amplitude of daily fluctuations in SV of 22 ml, in groups 1 and 2 - 15 ml. A hyperkinetic type of hemodynamic stress reaction was revealed on day 1 of SCTBI. The most pronounced increase in the mesor of the circadian rhythm of the stroke volume in patients of group 2 is due to the predominance of the severity of extracranial injury. A positive correlation between SV and body temperature indicated the leading influence of the systemic inflammatory response in increasing cardiac output in children of the 2nd group. The longest and most pronounced inversion of the SV circadian rhythm was found in group 3.*

Keywords: *circadian rhythm, stroke volume, severe concomitant traumatic brain injury, children.*

Relevance. The occurrence of syndromes of mutual burdening, severe pathological reactions in response to concomitant trauma have their own specifics, often manifest atypically, are difficult to correct and act as factors of secondary brain injury. Almost simultaneously, compensatory mechanisms are activated, which for some time can support the vital activity of organs and systems. Centralization of blood circulation by increasing the tone of peripheral vessels and internal redistribution of limited VBC in the interests of organs experiencing the greatest functional load in an extreme situation; an increase in the depth and frequency of external respiration as a mechanism for compensating for developing hypoxia; an increase in cardiac output, intensification of tissue metabolism in order to mobilize additional energy resources can lead to secondary damage to the injured brain, the development of multiple organ failure syndrome [1-5]. Due to the lack of information on hemodynamics, data on the reasons for the insufficient effectiveness of correction of cerebral circulation, we made an attempt to study the features of changes in cardiac output in the acute period of SCTBI in children aged 7.1-18 years.

Purpose of the work. To study the circadian rhythm of stroke volume in severe concomitant traumatic brain injury in children older than seven years.

Material and research methods. The indicators of a comprehensive examination of 36 patients of school age (7-18 years old) with severe concomitant traumatic brain injuries (SCTBI), admitted to the intensive care unit (ICU) of the neurosurgical department of the Republican Scientific Center for Emergency Medical Aid (RSCEMA) in the first hours after a traffic accident (RTA) - 33, catatrauma - 3 patients. Continuous hourly monitoring of hemodynamic parameters, including SBP, was performed for 30 days after CSTBI. According to indications, patients were started on invasive mechanical respiratory support (MRS) at admission. Mechanical respiratory support was started on artificial lung ventilation in (CMV) mode for a long time, with subsequent transfer to SIMV. Restoration of adequate spontaneous breathing and reflexes was an indication for extubation. The severity of the condition was assessed using the methods of scoring according to the scales for assessing the severity of concomitant injuries - the PTS scale (pediatric injury scale - Pediatric Trauma Score (PTS) (Tepas J. J. et al. 1985), assessment of the severity of injuries according to the ISS scale, the severity of acute cerebral insufficiency according to the Glasgow coma scale. Patients were considered in three groups according to the duration of intensive care in the ICU. Group 1 with the duration of intensive therapy (7.1 ± 1.8 days) included 11 children aged 11.5 ± 2.4 years, 2 - duration of stay in the ICU 13.9 ± 1.9 days consisted of 9 patients, mean age 12.5 ± 2.5 years, 3 - 16 patients 11.2 ± 2.3 years, duration of treatment in the ICU from 21 to 30 days. Comprehensive intensive therapy included the identification and timely correction of deviations: mechanical respiratory support (MRS),

analgesic, anti-inflammatory, hemostatic, antibacterial, stress-limiting, cytoprotective, infusion therapy, compensation for VBC deficiency, correction of protein, water and electrolyte balance disorders, after removal from shock, surgical to the extent of acceptable possibilities for early correction of identified disorders.

Table 1.
Characteristics of patients older than 7.1 years with SCTBI

	Group 1	Group 2	Group 3
Number of children	11	9	16
Boys/Girls	7/4.	4/5.	9/7,
RTA	7	8	15
Catatrauma	3	1	1
Bullet wound	1	0	0
Age, years	11,5±2,4	12,5±2,5	11,2±2,3
Days in hospital	15,4±5,8	27,1±7,7	41±13,2
Days in ICU	7,1±1,8	13,9±1,9	31,4±7,7
ALV CMV, days	3,3±1,1	11,6±2,8	12,6±8,4
IPPV+CMV, days	0	5,3±0,9	21±3
SIMV, days	0	6,7±4,6	12,7±5,8
Spontaneous breathing, days	6,4±1,7	5,4±2,3	10,7±4,9

There were no significant age-related features in the severity of SCTBI in groups (tab. 1). In all groups, the number of RTAs prevailed. There was a significantly significant increase in the duration of intensive care in the ICU in injured children of group 3 by 24 days more than in group 1 and by 14 days longer than in group 2. For injured children of the 1st group, ALV in the CMV mode proved to be quite effective for 3.3±1.1 days, in the 2nd group - 11.6±2.8 days, in the 3rd - 12.6±8.4 days. Attention was drawn to an attempt to obtain better results by conducting ALV in the IPPV mode, however, there was a need to transfer to CMV in group 2 with a duration of 5.3 ± 0.9, in group 3 - 21 ± 3 days. SIMV mode was limited in group 2 in 1 patient for 13 days and in group 3 in 2 patients for 18 and 12 days, followed by the restoration of spontaneous breathing. On average, the duration of MRS in SIMV mode in group 2 was about 50% of the duration of intensive care in the ICU. It should be noted that the severity of extracranial injuries prevailed on the state of these children, which made it possible to limit ourselves to the intermittent forced-auxiliary method of mechanical respiratory support SIMV. In almost all patients, AALV by CPAP was performed before the complete cessation of respiratory support for 2-5 hours.

Table 2.
Dynamics of the mesor of the circadian rhythm SV (ml)

Days	Group 1	Group 2	Group 3
1	56,3±5,4	64,0±6,1	53,0±5,1
2	50,2±2,3	72,3±3,7 "	50,1±1,9 □
3	48,8±2,2	68,0±3,6"	55,6±2,9 □
4	48,6±2,0	64,9±3,5"	51,9±2,5 □
5	49,9±2,5	63,4±3,9"	50,4±1,4 □
6	49,2±2,4	60,1±3,1"	51,2±1,9 □
7	46,5±2,6*	60,9±3,1"	51,2±2,8 □
8	50,0±4,0	63,2±3,2"	50,4±2,4 □
9	53,5±3,8	62,9±2,9"	49,2±2,6 □
10		59,8±2,8	51,3±2,7 □
11		62,5±4,9	50,9±2,7□
12		60,7±2,4	49,0±2,0 □
13		59,4±4,3	51,3±3,0 □
14		60,6±4,0	46,8±1,7 □
15		54,2±6,3	47,9±2,6
16			47,7±1,3
17			48,8±1,4
18			45,5±1,9*
19			47,1±1,9
20			46,0±2,2
21			51,7±1,6
22			46,7±1,6
23			48,1±1,7
24			48,4±2,5
25			46,4±2,0
26			46,4±2,1
27			44,2±2,9
28			44,4±2,6
29			46,4±3,8
30			49,5±3,1

*-the change is significant relative to the indicator on the first day

"-significant relative to group 1

□-significant relative to group 2.

Table 3.
Average hourly SV (ml)

Hours	Group 1	Group 2	Group 3
8	50,2±2,2	63,0±5,2 "	47,4±2,6 "
9	47,6±3,7	63,9±3,9 "	48,2±2,7"
10	48,9±1,9	62,6±3,8 "	49,4±2,8 "

11	49,8±2,5	62,4±6,1“	48,4±3,0 〱
12	49,8±2,9	61,5±5,5“	48,6±3,5 〱
13	48,5±2,0	63,0±5,0“	49,2±4,1 〱
14	50,6±6,1	60,3±5,7	48,6±3,8 〱
15	52,1±5,4	60,2±5,6	48,6±3,5 〱
16	52,0±4,5	61,3±5,5	49,2±2,7 〱
17	52,6±5,2	60,9±4,6	48,6±3,5 〱
18	48,6±2,8	64,0±4,0“	48,6±3,5 〱
19	50,3±2,7	64,8±4,2“	48,4±2,9 〱
20	49,0±1,9	64,1±6,1“	50,0±2,8 〱
21	47,7±2,4	61,7±5,0“	49,3±3,1 〱
22	49,9±2,0	61,8±4,8“	50,3±2,9 〱
23	51,2±5,1	62,1±4,1“	49,9±2,6 〱
24	48,7±4,1	62,6±4,6“	49,9±3,1 〱
1	49,2±3,0	63,7±4,0“	49,2±3,2 〱
2	50,7±3,8	62,5±5,2“	49,4±3,2 〱
3	51,8±3,7	62,2±5,3“	48,2±3,6 〱
4	51,6±5,2	61,7±3,9“	48,6±3,2 〱
5	52,1±3,3	63,6±4,5	48,7±3,2 〱
6	51,2±1,7	62,3±4,6“	49,0±3,1 〱
7	53,2±3,9	62,7±4,1“	47,9±3,5 〱

“-significant relative to group 1

〱- significant relative to group 2

“- significant relative to group 1

On day 1, all the injured showed a tendency to increase the circadian rhythm mesor SV. In the dynamics of the acute period of traumatic disease in group 1, only on day 7, a decrease in SV by 17% ($p<0.05$) was revealed, in group 3 by 15% on day 18 ($p<0.05$). The revealed indicators testified to the hyperkinetic type of hemodynamic stress reaction on the 1st day of SCTBI.

While in group 2 on days 2-9, cardiac output was greater than in group 1 by 44%, 42%, 33%, 27%, 22%, 30%, 26%, 18% ($p<0, 05$, respectively). Apparently, the hyperdynamic type of hemodynamics is due to more sparing stress-protective drug protection due to the fact that patients of group 2 differed somewhat in the predominant severity of extracranial injury, which made it possible, in conditions of a less pronounced clinical picture of acute cerebral insufficiency in mechanical respiratory support, to give preference to the SIMV mode (tab. 2). A significant decrease in the mesor of the circadian rhythm SV to physiological parameters in group 3 (Fig. 1) on days 2-14 by 30%, 20%, 18%, 20%, 15%, 15%, 20%, 20%, 13%, 19%, 17%, 13%, 22% ($p<0.05$, respectively) can be explained by a more

extensive drug stress-protective correction (anticonvulsants, hypnotics, sedatives, relaxants) aimed at preventing and correcting secondary mechanisms of brain damage associated with both the severity of TBI and extracranial damage to other organs and systems.

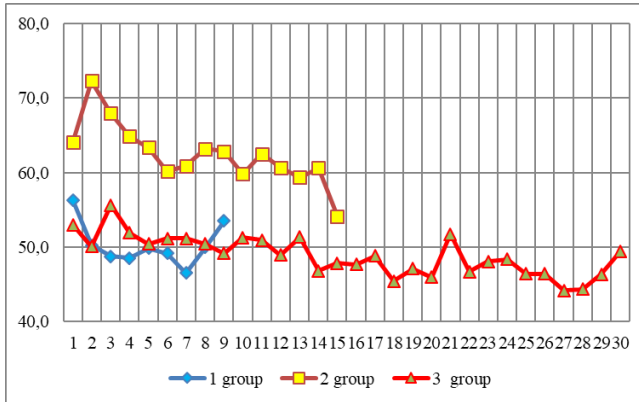


Figure 1. Dynamics of the SV circadian rhythm mesor older than 7 years in SCTBI

As shown in Table 3, the average level of hourly monitoring of impact ejection in group 2 turned out to be significantly higher than in group 1 in the daytime (8-13 hours) and (18-7 hours), and more than in group 3 as in the daytime, and at night, on average, by 10-15 ml (fig. 2).

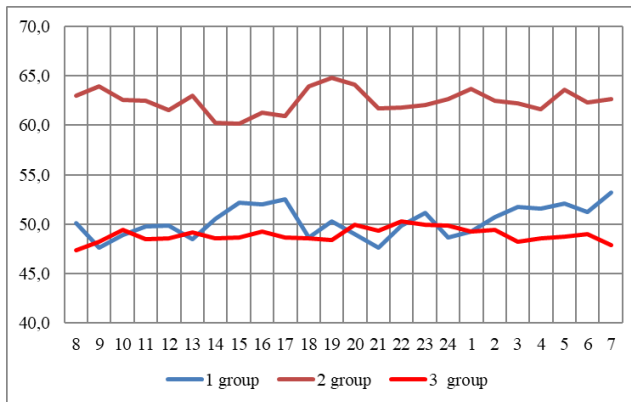


Figure 2. Influence of injury severity on mean hourly circadian rate SV over 7 years

The most pronounced instability of stroke volume was observed on the first day in children of group 3 with an amplitude of daily fluctuations in SV of 22 ml, in groups 1 and 2 - 15 ml (fig. 3). In the following days, the change in amplitude occurred in group 1 with a circa-weekly rhythm, in group 2 a 4-5 day rhythm, in group 3 the most pronounced deformation of the structural characteristics of the circa-weekly rhythm was revealed, which consisted in a decrease in the amplitude of the oscillation to 3-4 ml with an oscillation period of 5-3 days (fig. 3).

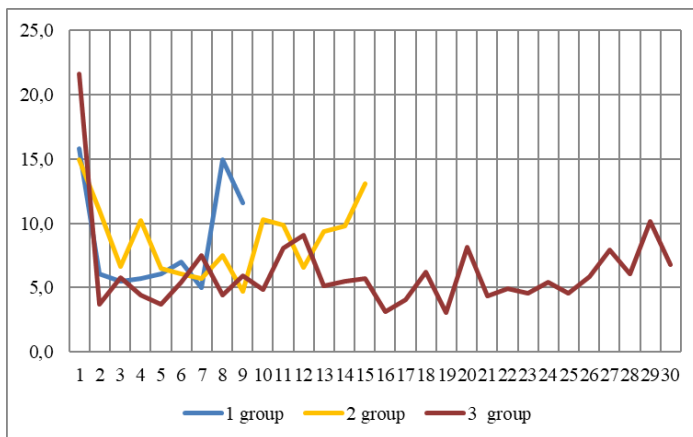


Figure 3. Dynamics of the amplitude of the circus rhythm SV (ml).

A negative correlation between SV and DBP was found in all examined children, which amounted to (-0.72) in group 1, (-0.7) in group 2, (-0.71) in group 3, which meant a hyperkinetic direction of changes in the acute period of SCTBI. A positive correlation between SV and body temperature indicated the leading influence of the systemic inflammatory response in increasing cardiac output in children of the 2nd group. In more severely injured children of groups 2 and 3, the change in PBP was directly dependent on the growth of the SV index. That is, with a more severe CTBI, the PBP value can be used to navigate the change in SV in group 1 (0.41), in group 2 - (0.73), in group 3 - (0.87), that is, PBP can indirectly characterize the dynamics of myocardial contractility in the most severely injured patients (fig. 4).

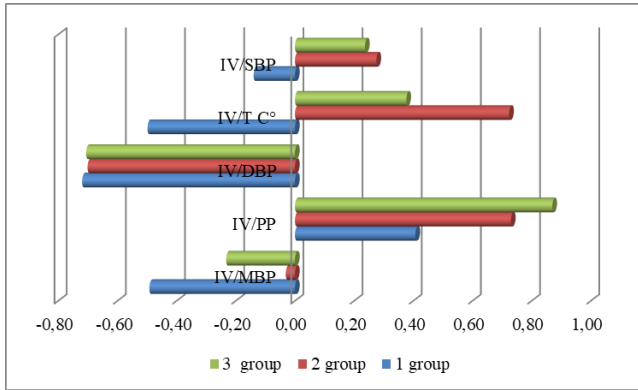


Figure 4. Correlation links for SV

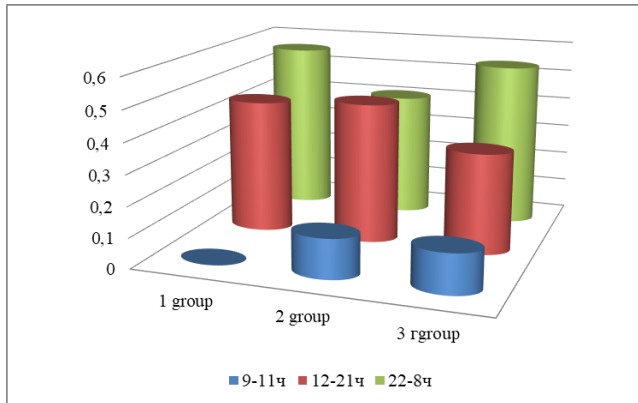


Figure 5. Duration, severity of acrophase shift

The longest and most pronounced inversion of the SV circadian rhythm characterized an increase in the load on the heart muscle at night with a risk of acute heart failure due to overload and depletion of energy resources in children of the 3rd group (fig. 5).

Conclusion. The most pronounced instability of stroke volume was observed on the first day in children of group 3 with an amplitude of daily fluctuations in SV of 22 ml, in groups 1 and 2 - 15 ml. A hyperkinetic type of hemodynamic stress reaction was revealed on day 1 of SCTBI. The most pronounced increase in the mesor of the circadian rhythm of the stroke volume in patients of group 2 is due to the predominance of the severity of extracranial injury. A positive correlation between SV and body temperature indicated the leading influence of the systemic

inflammatory response in increasing cardiac output in children of the 2nd group. The longest and most pronounced inversion of the SV circadian rhythm was found in group 3.

References

1. <https://fcdo.ru/lechenie-mkb/sdavlenie-golovnogo-mozga-neotlozhnaya-pomoshch-neotlozhnaya-pomoshch-pri.html>
2. <https://medbe.ru/materials/cherepno-mozgovye-narusheniya/printsipy-intensivnoy-terapii-tyazheloy-cherepno-mozgovoy-travmy/>
3. <https://sovterror.ru/arterialnoe-pulsovoe-davlenie-u-detej/>
4. <https://cardiogid.com/pulsovoe-davlenie/>
5. <https://vbgi.ru/cough/sochetannaya-cherepno-mozgovaya-travma-sochetannaya-cherepno-mozgovaya-i/>

DOI 10.34660/INF.2022.19.73.156

COVID-19 大流行后第二个成年冠心病女性的身体表现
**PHYSICAL PERFORMANCE OF WOMEN OF THE SECOND
ADULTHOOD WITH CORONARY HEART DISEASE AFTER THE
COVID-19 PANDEMIC**

Boyarskaya Larisa Aleksandrovna

Candidate of Medical Sciences, Associate Professor.

Tyumen State Medical University, Tyumen

Prokopyev Nikolay Yakovlevich

Doctor of Medical Sciences, Full Professor.

Tyumen State Medical University,

Tyumen

Ananiev Vladimir Nikolaevich

Doctor of Medical Sciences, Full Professor.

Institute of Biomedical Problems RAS, Moscow

Gurtovoy Elisey Sergeevich

Student

Tyumen State Medical University, Tyumen

Boyarskaya Elizaveta Alekseevna

Student

Tyumen State Medical University, Tyumen

抽象的。心脏病学首次给出了评估 49 名成年后第二个成年女性的身体表现 (PP) 的指标, 这些女性生活在西西伯利亚南部, 她们正处于接受冠心病 (CHD) 康复治疗住院阶段, 在 Covid-19 大流行之后。人类个体发育的第九个时期第一次被划分为相等的5年时期: 36至40岁、41至45岁、46至50岁和51至55岁。为了确定 PP 的水平, 作者使用了简单有效的阶梯测试 PWC 170 V.L. Karpman 医生, 因此心脏病专家和康复专家能够对中枢血流动力学的功能状态进行有效和持续的监测, 并通过理疗练习及时调整正在进行的康复治疗。作者发现 PP 和最大耗氧量 (MOC) 显著下降, 具体取决于女性的护照年龄。

关键词: 女性, 第二个成年期, 冠心病, 身体表现, Covid-19 大流行的后果。

Abstract. For the first time in cardiology, indicators are given for assessing physical performance (PP) in 49 women of the second adulthood, living in the south of Western Siberia, who are at the inpatient stage of receiving rehabilitation

treatment for coronary heart disease (CHD), after the Covid-19 pandemic. For the first time, the ninth period of human ontogenesis was divided into equal 5-year periods: from 36 to 40 years, from 41 to 45 years, from 46 to 50 years and from 51 to 55 years. To determine the level of PP, the authors used a simple and valid step test PWC 170 V.L. Karpman, thanks to which cardiologists and rehabilitologists are able to carry out competent and constant monitoring of the functional state of central hemodynamics and timely make adjustments to the ongoing rehabilitation treatment by means of physiotherapy exercises. The authors found a significant decrease in PP and maximum oxygen consumption (MOC) depending on the passport age of women.

Keywords: *women, second adulthood, coronary heart disease, physical performance, consequences of the Covid-19 pandemic.*

Relevance. To date, quite a lot of actual experience has been accumulated regarding the Covid-19 pandemic, which has made significant and so far not completely studied changes in the state of human health [1, 4, 7, 11, 13]. Today, maintaining and restoring the health of people who have had Covid-19 is one of the most important state tasks. In the international classifier of diseases ICD10, post-covid syndrome was included in the heading U09.9 - "Status after Covid-19, unspecified". Modern medicine is faced with a colossal disease in the population of various countries of the world, which required the mobilization of possible and impossible means and methods of diagnosis, treatment and prevention. Modern scientific and practical studies show that the consequences of Covid-19 can manifest themselves with a variety of symptoms: shortness of breath and chest pain, joint pain, fatigue, memory impairment, sleep disturbances, depressive states and fear, a decrease in the quality of life, etc. d. [12, 15, 18, 19, 21].

Currently, the rehabilitation of patients with coronavirus infection is carried out using medications and physical medicine technologies [20, 22, 23]. When it is carried out, especially in women with CHD, after suffering Covid-19, it is important to exercise competent medical control of the functional state of the body at various stages of rehabilitation [17, 24, which will significantly reduce mortality [5, 8, 9, 10, 16].

In the literature available to us, there are not enough scientific and practical studies that shed light on PP in women of the second period of adulthood living in the south of Western Siberia and suffering from CHD, especially after the Covid-19 pandemic.

Purpose of the study: in women of the period of the second mature age, suffering from CHD, after suffering Covid-19 according to the PWC 170 step test, determine the values of PP.

Material and methods. We examined 49 women of the second adulthood (47.4 ± 1.7 years) undergoing inpatient treatment at the FSBHCl WSMC FMBA of Russia in Tyumen for chronic CHD without signs of heart failure, who had Covid-19. The results of the anamnesis indicate that all women permanently resided in the south of Western Siberia. Considering that the period of the second mature age lasts from 36 to 55 years, i.e. is 20 years, we consider it not entirely correct to judge the PP of women, for example, 36 years old, and compare it with a woman of age, for example, 55 years old. In this regard, we divided the period of the second mature age into equal 5-year intervals: from 36 to 40 years (38.4 ± 1.4 ; $n = 11$), from 41 to 45 years (43.1 ± 1.2 ; $n = 13$), from 46 to 50 years (48.2 ± 1.3 ; $n = 12$) and from 51 to 55 years (52.7 ± 1.4 ; $n = 13$).

To assess PP, a step test by V.L. Karpman [6]. The calculation of PP was made according to the formula:

$$PWC\ 170 = N\ 1 + (N\ 2 - N\ 1) \times \frac{170 - f\ 1}{f\ 2 - f\ 1}$$

where: $N\ 1$ and $N\ 2$ – respectively, the power of the first and second loads, $f\ 1$ and $f\ 2$ – heart rate (HR, beats / min) at the end of the first and second loads.

The load power was calculated by the formula: $N = 1,3 \times p \times h \times n$,

where: N – work, kgm/min; p – body weight of young men, kg; n – steps per step per minute; h – step height, m; $1,3$ – coefficient that takes into account the amount of work when descending from the step.

The maximum oxygen consumption (MOC) was calculated using the formula: $MOC = 2,2 \times PWC170 + 1070$

Body weight was measured on a balance scale with an accuracy of 50 g.

In accordance with the clinical examination rules adopted by the FSBHCl WSMC FMBA of Russia Tyumen, all women underwent a comprehensive clinical, biochemical and instrumental examination before testing PP. Prior to the study, we asked women to sleep 8-9 hours a night; try to be in the ward or rooms of the clinic department at an air temperature in the range of $18-22^{\circ}$ Celsius; do not use medicines without a doctor's prescription; eat at least 4 times a day and drink at least two liters of drinking water; limit the use of salt in food.

The results of the study were processed on a personal computer using modern electronic programs (Statistika) [3]. The assessment of the significance of differences was carried out using Student's t-test, while the differences were considered significant at $p < 0.05$. The principles of voluntariness, the rights and freedoms of the individual, guaranteed by Articles 21 and 22 of the Constitution of the Russian Federation, as well as the Order of the Ministry of Health and Social Development of Russia №774n dated August 31, 2010 "On the Ethics Council" were observed. The study was conducted in compliance with the ethical standards set forth in the

Declaration of Helsinki and the Directives of the European Community (8/609EC) and the informed oral consent of women.

Results and discussion. Important for the study of PP, firstly, we consider a good emotional and psychological attitude of a woman to conduct testing, which consists in comprehensive information for her about the upcoming dosed physical activity and its importance for subsequent treatment not only with the use of drugs, but also with physical exercises. Secondly, a thorough clinical and instrumental examination, which allows assessing the functional state of central hemodynamics and identifying possible contraindications for the step test. Thirdly, the results of the PWC 170 step test will highlight the functionality of a woman for the upcoming rehabilitation treatment.

Based on the teachings of Academician A.A. Ukhomsky about the dominant, we explained to each woman that the physical load given by him when climbing steps of various heights is very far from the maximum load, is short-term and therefore its implementation does not present any particular difficulties and does not cause significant fatigue.

The results of the study of body weight indicated that due to the increase in the passport age, it increases. At the age of 36-40 years, body weight was 62.26 ± 2.30 kg, at 41-45 years old - 66.83 ± 2.39 kg, at 46-50 years old - 67.74 ± 2.33 kg, at 51-55 years old - 69.61 ± 2.26 kg (fig. 1).

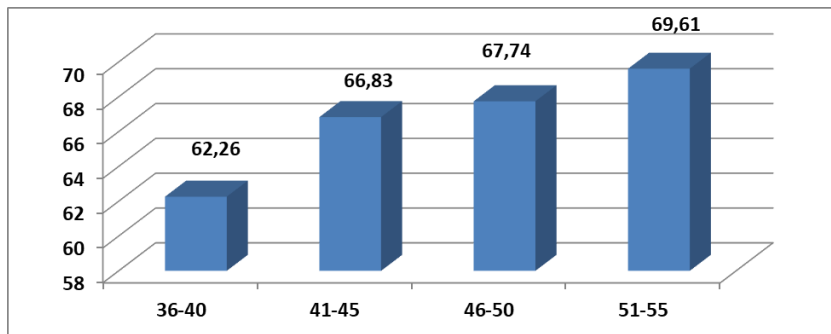


Figure 1. Age-specific body weights in second adult women with CHD after exposure to Covid-19.

Thus, during the 9th period of ontogeny, the age-related increase in body weight of women over the period from 36 to 55 years was equal to 7.35 kg.

Analyzing the results of the PP study, we note, firstly, that in all women, despite a previous infection with Covid-19 and the presence of a chronic course of CHD, PP was at the level of average values (tab. 1).

Table 1

Physical performance and maximal oxygen consumption in post-COVID-19 post-COVID-19 women of second adulthood with CHD

Age, years	PWC 170 kgm/min	PWC 170 kgm/min/kg	MOC, ml/min/kg
36-40	593,84±16,3	9,53±0,47	38,16±1,19
41-45	526,92±15,4	7,88±0,41	32,91±1,12
46-50	462,36±16,1	6,82±0,36	30,80±0,98
51-55	374,17±15,5	5,37±0,29	27,19±0,92

Secondly, a significant dependence ($p<0.05$) of a decrease in the level of PP due to an increase in the passport age was revealed. Thirdly, if the PP values (in kgm/min) in women under the age of 50 were at almost the same level ($p>0.05$), then after reaching the age of 50, PP significantly ($p<0.05$) became less (tab. 2).

Table 2

The difference in physical performance according to the step test PWC 170 kgm/min, depending on the passport age

Age, years	PWC 170 kgm/min	Age difference
36-40	593,84±16,3	-
41-45	526,92±15,4	66,92
46-50	462,36±16,1	64,56
51-55	374,17±15,5	88,19

Attention should be paid to such an important fact for the CHD clinic, which is the MOC index in women of the age we are studying. Due to the increase in passport age, MOC has a significant ($p<0.05$) downward trend. So, for the period from 36 to 55 years, MOC in absolute terms decreased by 10.97 ml/min/kg.

Thus, what we have said above testifies, firstly, to the high methodological correctness and scientific and practical value of the PWC170 step test. Secondly, one should not discount such an important fact as a short time for its implementation. The doctors of our clinic spent 13 minutes to perform the actual step test PWC170. Thirdly, directly during the test, not only mathematical calculations of the load power were performed, but also a positive emotional impact was carried out according to the type of dominant A.A. Ukhtomsky. We noticed that the creation of a dominant favorably influenced not only the course of the study, but also the functional state of women.

Long-term practice of using the step test PWC 170 highlighted some of the features in its implementation. We believe that the second load during testing should significantly exceed the power of work during the first load so that at the end of

the first load the heart rate in a woman reaches 110-130 beats/min, and at the end of the second load - 150-165 beats/min (but not more 170 bpm), while the difference was at least 40 bpm. If the difference between the power values of the first and second loads is small, and the difference in heart rate at their end is much less than 40 beats/min, then the accuracy of determining the PWC170 value is reduced.

Based on the study carried out, the following **conclusions** can be drawn:

1. In the conditions of any therapeutic department, to assess the level of PP, it is possible and necessary to use the easy-to-perform and valid step test PWC 170, which allows not only quickly, but also reliably monitors the functional state of the human body, especially after the previous Covid-19 pandemic.

2. In clinical therapeutic practice, the 9th age period of human ontogenesis should be considered not as a single one (36-55 years), but conditionally divided into equal time intervals, which will allow not only to individualize the process of examination and treatment, but also to carry them out taking into account the individual passport age.

3. PP and MOC in women of the second adulthood suffering from CHD, after suffering a Covid-19 pandemic, significantly depend on their passport age. When conducting rehabilitation treatment using physiotherapy exercises, the physician should keep in mind that as the biological age of women increases, their PP and MOC values decrease.

Conflict of interests. The authors declare no conflict of interest.

Research transparency. The study was not sponsored. The authors are solely responsible for providing the final version of the manuscript for publication.

Declaration of financial and other relationships. All authors were involved in topic development, study design, and manuscript writing. The final version of the manuscript was agreed and approved by all authors. The authors did not receive a fee for the study.

References

1. Goroshko N.V. *Healthy life expectancy in an aging population: global trends in the era of covid-19* / N.V. Goroshko, E.K. Emelyanova, S.V. Patsala // *Social aspects of public health*. – 2021. – V. 67. – № 2. – P. 9.
2. Dubovik A.V. *Influence of some factors on the effectiveness of the treatment of coronary heart disease* / A.V. Dubovik, Yu.O. Bryzhataya, E.A. Kontovsky // *Bulletin of emergency and reconstructive surgery*. – 2019. – V. 4. – № 4. – P. 99-107.
3. Glantz S. *Medico-biological statistics. Transl. from Eng. /S. Glantz*. – M.: Practice, 1998. – 459 P.

4. *Changes in social well-being and health of older women during covid-19: objective and subjective factors* / O.A. Anikeeva, V.V. Sizikova, S.N. Fomina, O.V. Beschelnova // *Problems of social hygiene, health care and the history of medicine*. – 2021. – V. 29. – № 51. – P. 731-735.
5. *Kanorsky S.G. Ischemic heart disease with a high risk of complications: how to identify such patients and choose management tactics?* / S.G. Kanorsky // *Rational pharmacotherapy in cardiology*. – 2020. – V. 16. – № 3. – P. 465-473.
6. *Karpman V.L. Study of physical performance in athletes* / V. L. Karpman, Z. B. Belotserkovsky, M. A. Gudkov. – M.: Physical education and sports, 1974. – P. 23-34.
7. *Kondashevskaya M.V. Therapeutic targets for coagulopathy covid-19* / M.V. Kondashevskaya // *Thrombosis, hemostasis and rheology*. – 2021. – № 1. – P. 12-17.
8. *Korolenko A.V. The impact of mortality from coronavirus infection on the life expectancy of the population of Russian regions* / A.V. Korolenko // *Problems of territory development*. – 2022. – V. 26. – № 3. – P. 56-74.
9. *Korkhmazov V.T. Excess mortality associated with the Covid-19 pandemic* / V.T. Korkhmazov // *Innovative medicine of Kuban*. – 2022. – V. 7. – № 2. – P. 5-13.
10. *Mityakov S.N. Substantiation of factors influencing the level of mortality from Covid-19* / S.N. Mityakov // *Development and security*. – 2021. – № 4 (12). – P. 4-18.
11. *Mikhailov N.G. On the methodology of studying the state of health during a pandemic* / N.G. Mikhailov, L.B. Zinnatullina // *Bulletin of the MSPU. Series: Natural Sciences*. – 2022. – № 2 (46). – P. 94-100.
12. *Murashchenkova N.V. Social axioms and fear of covid-19: a multigroup analysis of communication among students from three countries* / N.V. Murashchenkova // *Social psychology and society*. – 2022. – V. 13. – № 2. – P. 89-108.
13. *Features of the health status of the female population of the city of Moscow during the pandemic of coronavirus infection Covid-19* / A.M. Allenov, A.S. Arsenyan, L.S. Polonskaya, M.Sh. Hajiyeva // *National health*. – 2021. – № 4. – P. 23-26.
14. *Safonova O.A. Physical culture and sport in the development of physical performance* / O.A. Safonova, D.V. Safonov // *Colloquium-Journal*. – 2022. – № 6-1 (129). – P. 25-27.
15. *Traumatization by fear: psychological consequences of the Covid-19 pandemic* / V.I. Ekimova, M.I. Rosenova, A.V. Litvinova, A.V. Koteneva // *Modern Foreign Psychology*. – 2021. – V. 10. – № 1. – P. 27-38.

16. Association of Multiple Enrichment Criteria With Ischemic and Bleeding Risks Among COMPASS-Eligible Patients. / A. Darmon, E. Sorbets, G. Ducrocq, et al. // *J Am Coll Cardiol*. 2019; 73(25): 3281-3291. DOI: 10.1016/j.jacc.2019.04.046 EDN: AYTNZS

17. Effect of evidence-based therapy for secondary prevention of cardiovascular disease: Systematic review and meta-analysis. / T.T. Ma, I.C.K. Wong, K.K.C. Man, et al. // *PLoS One*. 2019; 14(1):e0210988. DOI: 10.1371/journal.pone.0210988

18. Into the looking glass: Post-viral syndrome post COVID-19. / R. Perrin, L. Riste, Hann M., A. Walther, A. Mukherjee, A. Heald // *Medical Hypotheses*. 2020; (144): 11055. DOI: 10.1016/j.mehy.2020.110055

19. Klitzman R.L. Needs to Prepare for "Post-COVID-19 Syndrome". / R.L. Klitzman // *The American Journal of Bioethics*. 2020; 20(11): 4-6. DOI: 10.1080/15265161.2020.1820755

20. Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations. / P. Thomas, C. Baldwin, B. Bissett, I. Boden, // *Journal of Physiotherapy*. 2020; 66(2): 73-82. DOI: 10.1016/j.jphys.2020.03.011

21. Post-COVID-19 Fatigue: Potential Contributing Factors. / A.C. Fietsam, J.R. Deters, A.D. Bryant, J. Kamholz // *Brain Sciences*. 2020; 10(12): 1012 p. DOI: 10.3390/brainsci10121012

22. Recommendations for respiratory rehabilitation in adults with COVID-19. / H. Zhao, Y. Xie, C. Wang et al. // *Chinese Medical Journal*. 2020; 133(13): 1595-1602. DOI: 10.1097/CM9.0000000000000848

23. Sheehy L.M. Considerations for Postacute Rehabilitation for Survivors of COVID-19. / L.M. Sheehy // *JMIR Public Health and Surveillance*. 2020; 6(2): e19462. DOI: 10.2196/19462

24. The myth of 'stable' coronary artery disease. Nat / K.A.A. Fox, M. Metra, J. Morais, D. Atar // *Rev Cardiol*. 2020; 17(1): 9-21. DOI: 10.1038/s41569-019-0233-y EDN: IAEDAO

DOI 10.34660/INF.2022.71.23.157

UDC 616.33-002.44

消化性溃疡病的神经源性和遗传因素
**NEUROGENIC AND GENETIC FACTORS OF PEPTIC ULCER
DISEASE**

Ivanov Leonid Nikolaevich

Doctor of Medical Sciences, Full Professor

I. N. Ulianov Chuvash State University

Kolotilova Marina Leonidovna

I.M. Sechenov First Moscow State Medical University

ORCID ID: 0000-0002-6887-7832

抽象的。

研究目的。作者对消化性溃疡病病因病机理论的改进。

材料和方法。为了发展作者对消化性溃疡病病因和发病机制的看法，处理了大约 50 种不同的出版物，并对自己的研究结果进行了分析。

结果。因此，胃溃疡和十二指肠溃疡的病因和发病机制的神经遗传理论最佳地解释了溃疡患者的因果关系，允许在某些情况下存在神经症或局部遗传因素。然而，很明显，只有神经源性因素与胃十二指肠系统的基因改变反应性（存在靶器官）相结合才会导致慢性溃疡。消化性溃疡病作为与心身病理学相关的疾病的理论（由本研究的作者提出）允许开发有效的治疗方法，包括具有心理矫正作用的药物。

关键词：胃溃疡，十二指肠溃疡，神经源性遗传因素，神经症，幽门螺杆菌。

Abstract.

Purpose of the research. *Improvement of the author's theory of the etiology and pathogenesis of peptic ulcer disease.*

Materials and methods. *To develop the authors' view of the etiology and pathogenesis of peptic ulcer disease, about 50 different publications were processed and the results of own research were analyzed.*

Results. *Consequently, the neurogenic-genetic theory of the etiology and pathogenesis of stomach ulcer and duodenal ulcer optimally explains the cause-and-effect relationship in a patient with ulcer, allowing for the prevalence of neurosis or local genetic factors in some cases. However, it is obvious that only a neurogenic factor combined with a genetically altered reactivity of the gastroduodenal system (the presence of a target organ) causes chronic ulcer. The theory (developed by the authors of the present research) of peptic ulcer disease as a*

disease related to psychosomatic pathology allows developing effective therapy, including drugs with psychocorrective action.

Keywords: *stomach ulcer, duodenal ulcer, neurogenic-genetic factors, neurosis, Helicobacter pylori.*

Introduction. The research aimed to improve the previously developed authors' theory of the etiology and pathogenesis of peptic ulcer disease (PUD). PUD is a crucial problem of modern theoretical and clinical medicine due to the high morbidity with complications, disability, and the ambiguity of etiological and pathogenetic mechanisms of its development.

The first authors' theory of the etiology and pathogenesis of PUD was published in 2005 [1].

Digestive system diseases occupy the third place after diseases of the respiratory and circulatory system, and the numbers tend to grow; besides, 60% of patients are of working age [2].

Due to the high morbidity and mortality from PUD, gastric ulcer and duodenal ulcer are not only a medical but a grave social problem [3; 4].

A number of theories exist on the etiology and pathogenesis of PUD: Ashoff's theory (the theory of mechanical damage to the mucous membrane); inflammatory theory; Bernard's peptic theory; theory of persistent ischemia of the mucous membrane; neurotrophic theory; viscerovisceral theory; K. M. Bykov's and I. T. Kurtsin's corticovisceral theory; endocrine theory, Vitebsky's valvular theory; bacterial theory, etc.

As known, gastric and duodenal ulcer disease is a chronic polyetiological recurrent disease the mechanism of which is complex changes in the nervous, hypothalamic-pituitary, hypothalamic-pituitary-adrenal and local gastroduodenal processes, leading to changes in trophic processes in the mucous membrane of the stomach and duodenum. In turn, the resulting ulcerative defect is a source of irritation of interoreceptors which hinders neurohormonal regulation. This vicious circle determines the chronic course of PUD [5, 6, 7].

One of the ideas about the alteration of the gastric and duodenal mucosa in pathophysiology was based on the theory of the role the nervous system plays in the regulation of metabolic and trophic processes that ensure the structural integrity and physiological (functional) state of the cell, tissue and organ [7, 8] ... The main concept here was by I.P. Pavlov (on the trophic function of the nervous system), and also the teachings of L.A. Orbeli on the adaptive trophic role of the sympathetic nervous system [9] and of P.K. Anokhin on functional systems [10].

A number of scientists considered the role of the hypothalamus and of the hypothalamus-pituitary-adrenal system in the pathogenesis of gastric ulcer and duodenal ulcer [11, 12, 13, 14].

Consequently, numerous scientists believe that the hypothalamus-pituitary-adrenal system plays a significant role in dysregulation and the occurrence of

dystrophic lesions of the stomach and duodenum; however, many mechanisms of such influence remain not fully understood.

Ulcer pathogenesis always includes vegetative-vascular dystonia (VVD) with an increase in the tone of the parasympathetic part of the nervous system [6]. Apart from it, PUD mechanisms include a decrease in the tone of sympathetic nerves, which can cause hyperplasia of the gastric glands with hypersecretion and simultaneous disturbance of the trophism of an overactive gastric mucosa [13; 14]. An attempt to reliably judge the nature of changes in autonomic tone in patients with ulcer using vegetative indices, electrocoagulogram, gastric secretion data, electrogastrogram (EGG) gave conflicting results [15; 16]. According to the Credo index, vagotonia was more often detected in patients with duodenum ulcer, and according to the index of the minute volume of blood flow, it was sympathicotonia. In patients with gastric ulcer, both of these tests more often revealed vagotonia. At the same time, EGG and electrocoagulography data indicated a significant sympathetic effect.

As known, emotional status is initially realized mainly through nerve stimuli entering the hypothalamus from the cerebral cortex, from reticular formation and from limbic system. Acetylcholine is believed to be the first mediator triggering such reaction, and further realization of the stress response occurs by neurogenic and hormonal pathways [13]. The sympathetic and parasympathetic subzones of the reticular formation are located at different levels of the central nervous system [15; 16]. Each of them closes its own group of adaptation rings, focused on its own group of effector apparatuses. Each type of receptor has its own adaptive reflex ring. Reticular neurons capable of autochthonous activity are sources of constant background signals in both channels of the autonomic nervous system. Each subzone of the reticular formation and their microzones with own spectrum of stimulating afferent signals are focused on the activation of their group of effector rings. Based on this, it is advisable to assess not the general vegetative tone but its constituent components on various organs and systems [16].

In addition to the vagus nerves, hormones of the endocrine glands (ACTH, cortisol, thyroxine, insulin, etc.) and gastrointestinal hormones (histamine, gastrin, bombesin), as well as 'substance P – a physiological gastrin activator [13]. Their aggressive effect, as a rule, is manifested when the activity of hormones that inhibit gastric secretion is decreased. These hormones include somatostatin, glucagon, calcitonin, sex hormones, secretin, cholecystokinin, urogastron, serotonin, prostaglandins, as well as endogenous opioids, enkephalins and endorphins.

Since the discovery of pyloric campylobacter in 1983 (*Campylobacter pylori*) now called *Helicobacter pylori* (HP), the infectious theory of gastric ulcer was subjected to large-scale studies [16]. As known, the areas of gastric metaplasia in the duodenum are a cellular target for HP. According to experimental data, the

formation of foci of gastric metaplasia in the duodenum is possible by long-term irrigation of its mucous membrane with hydrochloric acid. It is believed that the intensification of acid production in the stomach and prolonged acidification of the duodenum causes the development of foci of gastric metaplasia in it, creating conditions for its colonization by HP.

Despite the abundance of developments and theories of PUD, half of the HP-negative cases have no explanation for the genesis of the disease [16]. Helicobacteriosis is diagnosed in 2/3 of patients with duodenal ulcer, and in 2/5 of patients with gastric ulcer. Thus, it is not necessary to talk about 100% bacterial infection in case of ulcer. The HP infection acts as a local factor that influences the mucous membrane from the outside and activates the factor of aggression. The authors of the present research tend to agree, i.e. HP is considered as only a pathogenetic link that occurs against the background of a decrease in local immunity and other altering factors in the gastroduodenal system.

The fact that *H. pylori* invading the gastrointestinal tract does not cause ulcerative process, as, for example, in a large percentage of cases of gastritis without ulcers in the presence of HP, is convincing evidence that HP is not an etiological factor in the development of gastric ulcer or duodenal ulcers [17, 3]. Currently, there is no experimental model of peptic ulcer disease with *H. pylori* [1].

According to A.A. Soshina et al. [4], PUD is associated with *H. pylori* in 22.7% of patients, and duodenal ulcer in 80.9% of patients.

N.I. Zhernakova [18], investigating the clinic, pathogenesis and therapy of elderly PUD patients, found that of 178 patients, 147 suffered from gastric ulcer associated with *H. pylori*, and 31 patients had no infection. At the same time, the author notes that the infection aggravates the course of PUD. The leading indicators that guarantee a favorable course of the disease are elimination of *H. pylori* and normalization of the neuroendocrine status.

According to the data collected by the authors of the present research [19], in patients with acute ulcer, the concentration of cortisol is higher than in the control group ($P < 0.05$).

According to literature [17], 70-80% of duodenal and 50-60% of gastric ulcers are associated with *H. pylori*. However, it is necessary to clearly understand that association does not mean causality in any way.

Currently, none of the PUD pathogenesis theories encompasses the variety of involved functions and their shifts leading to stomach and duodenum ulcers [16]. Therefore, a versatile study of the physiological processes in patients with ulcer at different stages of the disease in case of various treatment methods is relevant. Therapy (taking into account the modern 'Standards for the quality of diagnosis and treatment of digestive system diseases' (Ministry of Health RF No. 125 dated 17.04.98) affects only the local factors ulcer pathogenesis – HP and peptic factor [16].

Thus, one has to consider the existence of diverse mechanisms for the development of ulcerative lesions of the mucous membrane in the stomach and duodenum. Probably, none of these mechanisms plays an independent role that determines the formation and chronicity of gastric and duodenal ulcers, and only their combination can determine the nosological form of ulcerative lesions of the mucous membrane [16, 20, 21].

Materials and research methods. To develop and improve the authors' view of the etiology and pathogenesis of PUD, about 50 different publications were processed, the results of own research and a number of views and opinions were analyzed [1; 21; 22]. These were assessed against the background of M.L. Kolotilova's opinions and views formed as a result of years of practical medical activity.

Results. Based on the results of own research and analysis of literature data, the authors propose an improved concept of the etiology and pathogenesis of peptic ulcer called 'neurogenic-genetic theory' (Fig. 1) [1, 21, 22, 23]. It is important that man is a biosocial subject, subject to the actions of various psycho-neurogenic factors.

Prolonged and chronic overstrain of neuropsychic processes due to emotional upheavals, chronic stress, various kinds of conflict and difficult situations, chronic pain syndromes and other similar processes causes a violation of the functional relationships of the cerebral cortex and subcortical centers, as well as centers of the autonomic nervous system. At the same time, a 'disinhibition', possibly inertness of some vegetative centers occurs. Autonomic regulation of organs and systems of organs is violated: cardiovascular system, respiration, digestive tract, endocrine system, etc. Moreover, depending on the genetic and ontogenetic reactivity of an organ, a system of organs or an organism as a whole, in each specific case, the outcomes of such psychogenic-nervous influence will be completely different, that is, the occurrence of a somatic disease of a functional or organic nature is determined by the pathogenic function of the autonomic nervous system which is out of control of higher neuropsychic activity and by characteristics of genetically (ontogenetically) impaired reactivity of an organ or a system of organs.

Thus, psychogenic-nervous and vegetative-visceral disorders determine the nosological form of psychosomatic illness due to disturbed genetic or ontogenetic (transferred diseases) organ reactivity. The authors' concept of the role played by neurogenic factors is confirmed by well-known literature data: in experimental neuroses, the formation of ulcers in monkeys and dogs was noted in 15% of cases, and in rats in 76% of cases. However, PUD is not formed without some genetic factor.

According to modern data, hereditary complication of ulcer occurs on average in 30% of patients [16]. First of all, it is an increase in the parietal cells in the gastric mucosa, hypertonus of vagus nerve, gastrin overproduction, pepsin overproduction, mucopolysaccharide (fucose) deficiency, secretory IgA deficiency, D-cell insufficiency of the stomach and duodenum, decreased sensitivity of the parietal

cells to somatostatin. Many of those factors are transmitted in the autosomal dominant manner (Fig. 1).

According to literature data, organ genetic features also include: hyperplasia of the glandular epithelium of the stomach, decreased secretion of mucus by the glands, anomaly of gastric vessels, and metabolic disorders in the glandular cells of the stomach.

T.A. Zagromova et al. [24], investigating the constitutional differences in the activity of proteinases and their inhibitors in PUD compared to the control group (healthy people), came to the conclusion that in duodenal ulcer, constitutionally mediated differences in the activity of proteinases and their blood plasma inhibitors are determined, which can affect the clinical manifestation and course of ulcer.

The likelihood of PUD also depends on the hereditary factor [16]. If there is a history of ulcers in blood relatives of first-degree relationship, duodenal ulcers occur about 3 times more often, and the tendency is transmitted through the male line. At the same time, increased density of parietal cells in the gastric mucosa, excessive activity of pepsinogen 1 production, and a deficiency of pepsin inhibitors, fucoglycoproteins, and excessive release of gastrin due to stimulation are genetically determined.

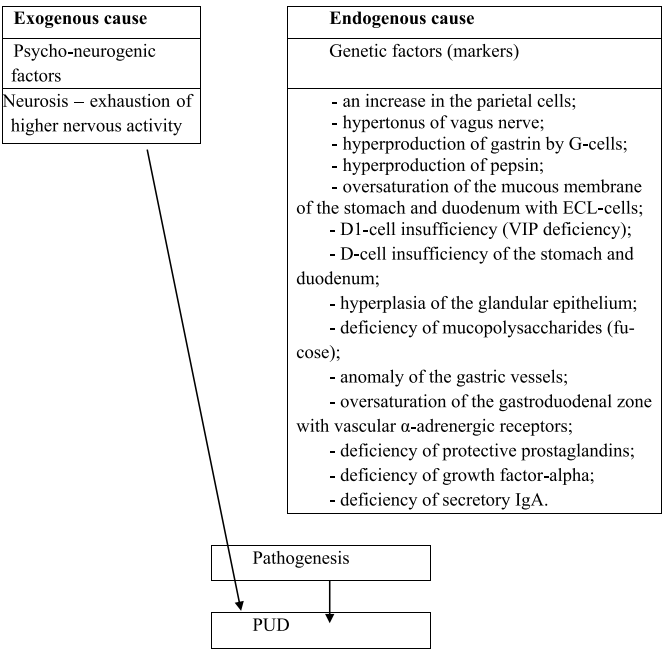


Figure 1. Etiology of PUD (L.N. Ivanov, M.L. Kolotilova).

Thus, the authors of the present research believe (Fig. 1; 2) that prolonged and chronic neuropsychic overstrain (neuroses) lead to neuro-vegetative and neuroendocrine (through the autonomic nervous system) dysregulation of the activity of organs or a system of organs, mainly organs with genetically or ontogenetically impaired reactivity, in this case the stomach. In other words, the stomach becomes a target organ. The following neuro-vegetative and neuroendocrine disorders in the regulation of morphofunctional activity of the stomach cause ulcerogenesis followed by chronicity (i.e. peptic ulcer): hypertonus of vagus nerve; instability of adrenergic influence; hyposecretion of ACTH, glucocorticoids, insulin, and thyroxine; deficiency of somatostatin, glucagon, and endogenous opioids (enkephalins, endorphins); disturbances in the neurotrophic supply of microcirculation, aggravating genetically or developmentally deviated features of gastric reactivity acid-peptic factor; gastrin overproduction; deficiency of mucopolysaccharides (fucose), secretory IgA, and gastrin; D-cell insufficiency of the stomach; decreased sensitivity of the parietal cell receptors to somatostatin; peculiarities of intracellular metabolism of gastrocytes; deficiency of protective prostaglandins, and peculiarities of gastric blood supply (Fig. 2). Notably, disorders of the dynamic relationships of cortical processes and of the system of subcortical vegetative (mainly hypothalamic) centers also depend on individual genetic or ontogenetic characteristics and not only on the intensity of psychogenic factors.

V.V. Chernin [25; 26] believes that including drugs that normalize neuroendocrine shifts in the complex therapy of peptic ulcer helps eliminate the effect of pathogenetic factors, significantly accelerating the healing time and increasing the percentage of scarring, reducing the occurrence of relapses of the disease.

O.A. Maslova [27] writes that neuropsychic overload precedes the onset and exacerbation of PUD in 56% of cases. In this regard, treatment (in addition to antisecretory and antibacterial agents) included the neuroleptic sulpiride (prosulpin) at 200 mg/day for 14 days to study its effect on the results of treatment and on patients' anxiety. In patients with acute gastric ulcer and duodenal ulcer, prosulpin in the above dose can double the rate of red scars at the site of the ulcer.

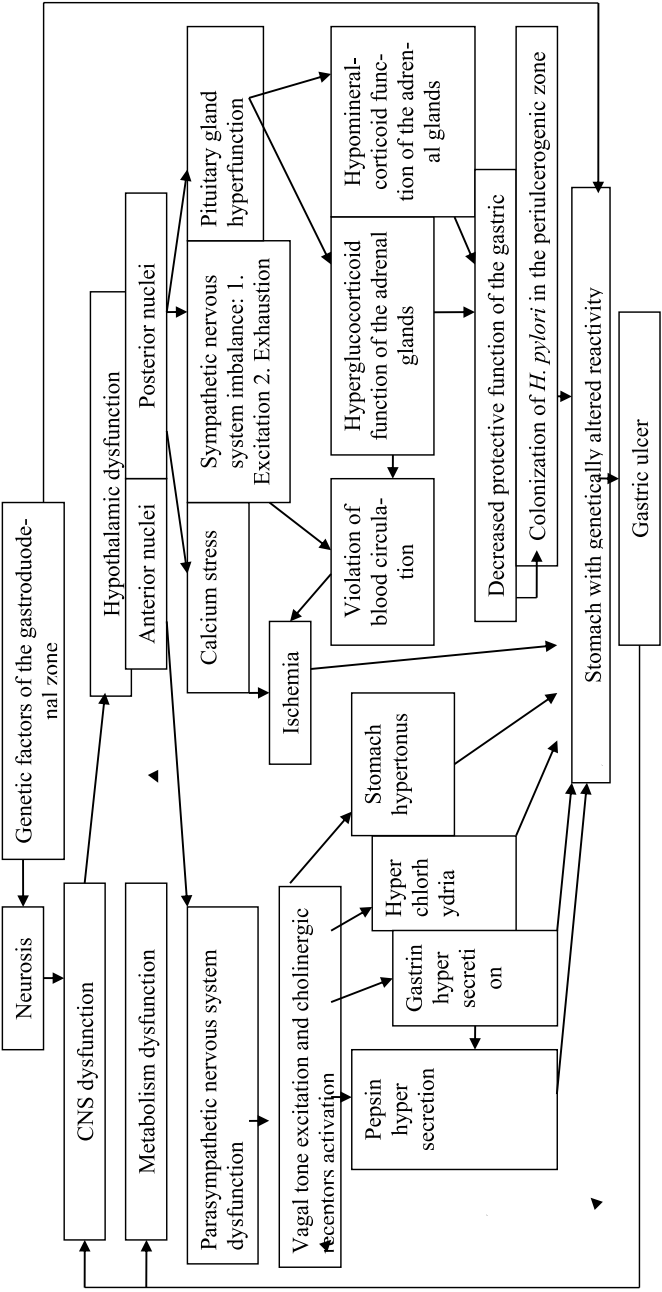


Figure 2. Etiology and pathogenesis of gastric ulcer (L.N. Ivanov, M.L. Kolotilova).

We attach particular importance to the decreased resistance of gastrocytes in the mucous membrane of the stomach and duodenum to *H. pylori* in the periulcerogenic zone. *H. pylori* leads to inflammatory infiltrate in gastric mucosa, and is usually accompanied by morphological signs of gastritis [2; 16]. The gene encoding the synthesis of a special protein (nap A) that activates neutrophils has been identified in all the strains of *H. pylori*. Consequently, the bacteria possess a specific quality – they cause neutrophilic infiltration of gastric mucosa. *H. pylori* adhering to gastrocytes causes reorganization of the cytoskeleton of epithelial cells, as well as a number of other changes. At the same time, epithelial cells respond to this by producing cytokines (interleukin-8) and some other chemokines. As known, these cytokines also lead to the migration of leukocytes from the blood vessels, developing an active stage of inflammation. Activated macrophages secrete interleukin-1 and tumor necrosis factor (TNF- α); these increase the sensitivity of the receptors of lymphoid, epithelial and endothelial cells, which in turn continues to attract a new wave of cells into gastric mucosa that are involved in immune and inflammatory reactions. The authors of the present research believe that in some cases, the process can have positive, i.e. anti-inflammatory influence, strengthening local immunity. This explains the results of the research by O.L. Belova and I.M. Belov [28], who came to the conclusion that *H. pylori* is not involved in ulcerogenesis, since reparation of mucosal ulcers cannot progress if an etiological or a pathogenic factor is present, and successful eradication of *H. pylori* slows down scarring of gastric and duodenal ulcer in patients with PUD. The significance of the local resistance of gastric mucosa in the etiology and pathogenesis of ulcer is supported by the data of S.N. Bazlov and E.N. Egorova [29].

M.A. Butov believes general and local disorders of vegetative tone in combination with hypercoagulation and local disturbances of blood flow create conditions for hemorrhages and necrosis in the mucous membrane of the gastroduodenal zone, reducing the effectiveness of local factors of protection and resistance [16]. The authors of the preset research believe that in conditions of chronic neurosis, changes (both general and local) in vegetative tone are significant.

I.V. Maev et al. [30] investigated the prevalence of autonomic, anxiety and depressive disorders in patients with PUD and the efficacy of grandaxin (Hungary) in treatment. The authors found constitutional autonomic dysfunction in 41% of patients. Kellner's test revealed a depressive disorder in 38% of patients. Anxiety disorders were detected in 82% of patients.

Figure 2 shows that calcium stress plays a significant role in ulcer pathogenesis by increasing the digestive capacity of gastric juice.

According to G.N. Kryzhanovsky [12], cellular processes arising under pathological stress include: increased Ca^{2+} entry into the cell from the extracellular space and its exit from cell stores (mitochondria and sarcoplasmic reticulum). The

increased Ca^{2+} entry and the inefficiency of the energy-dependent Ca^{2+} -ATPase, 'a pump' that pumps Ca^{2+} out of the cell, leads to an uncontrolled overload of the cell with calcium. This condition can be defined as calcium stress on the cell, and it has extremely negative consequences. The parietal cells of the stomach have separate receptors for acetylcholine, histamine and gastrin [16; 31]. The vagus nerve regulates the level of acetylcholine secretion, its influence is realized through the M-muscarinic receptors present on the surface of both parietal and enterochromaffin-like cells (ECL). These cells also have surface receptors for gastrin; its secretion occurs from G-cells under the influence of a food factor. The action of both acetylcholine and gastrin in both types of cells (ECL and parietal) is mediated through an increased level of intracellular calcium ions (Ca^{2+}). In the first case, the result of their action is the release of histamine, and in the second, it is the stimulation of HCl secretion by the parietal cells of the stomach. As known, histamine secreted by ECL and acting on H_2 receptors exerts its influence through the system of cyclic adenosine monophosphate (cAMP) [31]. Acetylcholine and gastrin act on gastric acid secretion by increasing the level of ionized Ca^{2+} in the cytoplasm of parietal cells [13]. In addition, under pathological stress, excessive activation of lipases and unregulated increase in free radical oxidation (FRO) processes occur which lead to oxidative stress of the cell; the content of intracellular free fatty acids increases; damage to cell membranes and mitochondria, energy defect, violation of the activity of energy-dependent pumps and other violations of intracellular homeostasis occur [12].

Thus, the consequence of chronic pathological stress are 'vicious circles' – calcium stress of the cell and oxidative stress of the cell, which in turn leads to high activation of the peptic factor, to spasms of small blood vessels in the wall of the stomach and duodenum, to hypercoagulation with microthrombi formation and, accordingly, to ischemia.

A significant violation of microcirculation in the proximal parts of the gastrointestinal tract, namely in the stomach and duodenum, occurs due to the large number of vascular alpha-adrenergic receptors in them. Naturally, such microcirculation disorders with local ischemia contribute to ulcerative lesions of the stomach and duodenum (Fig. 1). According to B.R. Gelfand et al. [32], local ischemia of the gastric mucosa is accompanied by excessive abnormal synthesis of nitric oxide, O_2 radicals, cytokines, by decreased synthesis of protective prostaglandins, death of epithelial cells and inhibition of their regeneration process.

Consequently, the neurogenic-genetic theory of the etiology and pathogenesis of stomach ulcer and duodenal ulcer optimally explains the cause-and-effect relationship in a patient with ulcer, allowing for the prevalence of neurosis or local genetic factors in some cases. However, it is obvious that only a neurogenic factor combined with a genetically altered reactivity of the gastroduodenal system (the

presence of a target organ) causes chronic ulcer. In confirmation of the authors' concept, O.L. Belova and I.M. Belova [33] note that despite the recognized role of *H. pylori* in the development of PUD in humans, to this day there is no scientific justification for proving such causation. Moreover, the authors note *H. pylori* is only a minor member of the stomach microbiota – of the huge acid-resistant microbiocenosis, *H. pylori* accounts for about 1% of all types of bacteria, and about 60 species of bacteria are present in the gastric mucosa.

The authors of the present research believe that a 'vicious circle' is formed in the pathogenesis of PUD. Peptic stomach ulcer or duodenal ulcer causes this pathology through the overstrain of the central nervous system, in other words, cause-and-effect relationships are reversed. Pathogenic afferentation from the gastric (duodenal) interoreceptors creates the possibility of the reverse effect of the ulcer of these organs (vestral signals) on the central nervous system and the mental sphere, causing an overstrain of the cortical processes.

Notably, the standards for the treatment of PUD in general are based on the decisive role of *Helicobacteria* in the etiology and pathogenesis of gastric ulcer and duodenal ulcer. From the point of view of the role of psycho-neurogenic and genetic factors in the etiology of PUD, the standard of treatment should include drugs with psycho-corrective action (neuroleptics, anxiolytics) and with general sedative action as part of etiotropic therapy. This approach will significantly increase the effectiveness of complex therapy, accelerating the healing and scarring of ulcers, reducing the recurrence of the disease and increasing the role of primary and secondary prevention.

With regard to genetic therapy as part of the etiotropic therapy, this is an issue for the future of gastroenterology and gene therapy. However, the authors of the present research believe that without successful genetic therapy, it is impossible to achieve complete exclusion of chronic ulcer disease and its recurrence.

Conclusions.

The bacterial theory of the etiology and pathogenesis of PUD does not reveal the whole essence of its genesis and does not have experimental evidence.

According to the bacterial theory of the etiology of PUD, anti-bacterial therapy is etiotropic; however, according to the neurogenetic-genetic theory, antibacterial therapy is pathogenetic.

The neurogenic-genetic theory of PUD as a psychosomatic pathology with a genetic component assumes psychocorrective drugs (taking into account the genetic characteristics of the organism) as etiotropic therapy.

In the pathogenesis of PUD, a 'vicious circle' is formed, since pathogenic visceral afferentation causes a secondary overstrain of cortical processes. The ongoing etiotropic therapy should break this 'vicious circle'.

References

1. Ivanov L.N., Kolotilova M.L. Neurogenic and genetic causes and mechanisms of development of peptic ulcer disease. *Experimental and clinical gastroenterology [Nevrogennye i geneticheskiye prichiny i mekhanizmy razvitiya yazvennoi bolezni. Eksperimentalnaya i klinicheskaya gastroenterologiya]*. M.: 2005; 4: 13-18
2. Ivashkin V.T., Rapoport S.I. The decision of the collegium of the Ministry of Health is a way to solve the urgent problems of gastroenterology. *Russian journal of gastroenterology, hepatology and colo-proctology [Reshenie kollegii MZ – put k resheniyu aktualnykh zadach gastroenterologii. Rossiiskiy jurnal gastroenterologii, gepatologii koloproktologii]* M.: 2004; 14; 5: 30
3. Kirilenko T.B., Kirilenko M. G. Temporary disability of patients with peptic ulcer disease. *Healthcare of the RSFSR [Vremennaya netrudosposobnost bolnykh yazvennoi boleznyu Zdravookhraneniye RSFSR]* 1989; 1: 23-26
4. Soshina A.A., Sergeeva V.V., Zinyaeva T.V. Features of the clinical picture and prognosis in patients examined at the bureau of medical and social expertise in connection with gastric ulcer and duodenal ulcer. *Kazakh medical journal [Osobennosti klinicheskoi kartiny i prognoz u pacientov osvidetelstvovannykh v byuro medico-socialnoi ekspertizy v svyazi s yazvennoi boleznyu jeludka i dvenadcatiperstnoi kishki. Kazahskii meditsinskii jurnal]*. 2013; 94; 1:124-127
5. Boger M.M. Ulcer disease [Yazvennaya bolezni]. Novosibirsk: Nauka. 1986; 256
6. Vasilenko V.H., Grebenev A.L., Sheptulin A.A. Ulcer disease [Yazvennaya bolezni] M.: Nauka 1987
7. Piper D., Hent I., Heap T. The healing rate of chronic gastric ulcer in patients admitted to hospital *Scand. J. Gastroent.* 1980; 15; 1: 113-117.
8. Golikov S.N., Dolgo-Saburov V.B., Elaev N.R. et al. Cholinergic regulation of biochemical systems of the cell [Holinergicheskaya regulatsiya biokhimicheskikh sistem kletki] M.: Nauka 1985; 319
9. Orbeli L.A. Lectures on the physiology of the nervous system [Lektsii po fiziologii nervnoi sistemy]. M.: L.: 1938; 312
10. Anohin P.K. Essays on the physiology of functional systems. [Ocherki po fiziologii funktsionalnykh sistem] M.: 1975; 447
11. Baranova M.N., Chernosvitov E.V. Clinical features of neurosis-like conditions in various neurotic diseases [Klinicheskiye osobennosti nevrozopodobnykh sostoyanii pri razlichnykh nevroticheskikh zabolevaniyakh] Tbilisi: 1990; 235.
12. Krijanovskii G.N. Introduction to general pathophysiology [Vvedenie v obshchuyu patofiziologiyu] M.: 2000; 71.
13. Polak D.M., Bloom S.R., Wright N.A., Butler A.G. Physiology and pathophysiology of the gastrointestinal tract. M.: 1989; 320.]

14. Sonnenberg A., Muller-Lisner S. Prediction of duodenal ulcer healing and relapse. *Gastroenterology*. 1981; 81; N5: 1061-1067.

15. Loginov A.S., Arbuzov V.G. Secretion of cortisol and growth hormone in patients with gastric ulcer and duodenal ulcer. *Theurapetic arhive [Sekreciya kortizola i gormona rosta u bolnih yazvennoi bolezni jeludka i 12-perstnoi kishki. Terapevticheskii arhiv]* 1988; 2: 15-17.

16. Butov M.A. On the etiology and pathogenesis of peptic ulcer disease. *Gastroenterology. [Ob etiologii i patogeneze yazvennoi bolezni. Gastroenterologiya]* M.: 2003; 5: 5-9.

17. Gorshkov A.N., Byakov M.Yu., Ivanchenko T.V. The frequency of *Helicobacter pylori* infection in erosive and ulcerative lesions of the stomach and duodenum. *Russian journal of gastroenterology, hepatology and colo-proctology [Chastota inficirovannosti helicobacter pylori pri erozivno-yazvennih porajeniya jeludka i dvenadcatiperstnoi kishki. Rossiiskiy jurnal gastroenterologii, gepatologii koloproktologii]* M.: 2004; 14; 5: 27

18. Zhernakova N.I. Clinical neuroimmunoendocrinology of peptic ulcer disease in the elderly. *Russian journal of gastroenterology, hepatology and colo-proctology [Klinicheskaya neuroimmunoendokrinologiya yazvennoi bolezni u lyudei pojoligo vozrasta. Rossiiskiy jurnal gastroenterologii, gepatologii koloproktologii]* M.: 2013; XXIII; 2: 88-89

19. Kokurkin G.V., Ivanov L.N., Semenov V.D. et al. Reactivity of the body when exposed to laser puncture on the healing of gastroduodenal ulcers. Abstracts of the I congress of immunologists and allergists of Chuvashia, "Scientific and practical aspects of modern immunology and allergology" [Reaktivnost organizma pri vozdeistvii lazeropunkturoi na zajivlenie gastroduodenalnih yazv. Tezisy I sjezda immunologov i allergologov Chuvashii "Nauchno _prakticheskie aspekti sovremennoi immunologii i allergologii"] Cheboksari: 1991; 60.

20. Malfertheiner P., Megraud F., O'Morain C. et al. Current concepts in the management of *Helicobacter pylori* infection: the Maastricht III Consensus Report. *Gut.*, 2007; 56: 772-781.

21. Ivanov L.N., Kokurkin G.V. A look at the etiology of gastric ulcer. Materials of the 3rd rep. conf. of surgeons of the Chuvash SSR 'Topical issues of surgery of gastric ulcer and 12 duodenal ulcer' [Vzglyad na etiologiyu yazvennoi bolezni zheludka. Materialy 3-i resp. konf. hirurgov Chuvashskoi SSR 'Aktualnie voprosi hirurgii yazvennoi bolezni zheludka i 12-perstnoi kishki'] Cheboksari: 1992; 6-7

22. Kolotilova M.L., Ivanov L.N. Ulcer disease [Yazvennaya bolezni] Cheboksari: 2006; 116p.

23. Grigorev P.A. Peptic ulcer and duodenal ulcer [Yazvennaya bolezni zheludka i 12-perstnoi kishki] M.: 1986; 222p.

24. Zagromova T.A., Akbasheva O.E., Cigolnik M.D. Constitutional differences in the activity of proteinases and their inhibitors in peptic ulcer disease. Russian journal of gastroenterology, hepatology and colo-proctology [Konstitucionalnie razlichiya v aktivnosti proteinaz i ih ingibitorov pri yazvennoi bolezni. Rossiiskiy jurnal gastroenterologii, gepatologii koloproktologii] M.: 2004; 14; 5: 29
25. Chernin V.V. Ulcer disease [Yazvennaya bolezni]. Tver: TSMA 2000; 287
26. Chernin V.V. Disorders of neuroendocrine regulation in the pathogenesis of peptic ulcer disease and ways of their correction. Materials of the IX Congress of the Scientific Society of Gastroenterologists of Russia (Appendix 1 to the journal Experimental and Clinical Gastroenterology 2; 2009) [Narusleniya neuroendokrinnoi regulyatsii v patogeneze yazvennoi bolezni i puti ih korrektsii. Mat. IX sjezda nauchnogo obshchestva gastroenterologov Rossii (Prilozhenie № 1 k jurnaluh Ekspirimentalnaya i klinicheskaya gastroenterologiya 2; 2009)] M.: 2009; 111-112.
27. Maslova O.A. Clinic-statistical study of the prevalence of gastric ulcer and duodenal ulcer and the tactics of its treatment. Russian journal of gastroenterology, hepatology and colo-proctology [Kliniko-statisticheskoe issledovanie rassprostranennosti yazvennoi bolezni zheludka i dvenadcatiperstnoi kishki i taktika ee lecheniya. Rossiiskiy jurnal gastroenterologii, gepatologii koloproktologii] M.: 19; 1: 89-90
28. Belova O.L., Belova I.M. Helicobacter pylori accelerates the process of scarring of ulcers of the gastric and duodenal mucosa. Russian journal of gastroenterology, hepatology and colo-proctology [Helicobacter pylori uskoryaet process rubcevaniya yazvi slizistoi obolochki zheludka i dvenadcatiperstnoi kishki. Rossiiskiy jurnal gastroenterologii, gepatologii koloproktologii] M.: 2004; 14; 5: 65
29. Bazlov S.N., Egorova E.N. The use of Biphilis in the treatment of recurrent ulcer disease. Russian journal of gastroenterology, hepatology and colo-proctology [Primenenie bifiliza v lechenii recidiva yazvennoi bolezni. Rossiiskiy jurnal gastroenterologii, gepatologii koloproktologii] M.: 2004; 14; 5: 20
30. Maev I.V., Dicheva D.T., Petrova E.G. Study of the peculiarities of the psychological status in patients with peptic ulcer disease. Russian journal of gastroenterology, hepatology and colo-proctology [Issledovanie osobennosti psihologicheskogo statusa u bolnih yazvennoi boleznyu. Rossiiskiy jurnal gastroenterologii, gepatologii koloproktologii] M.: 2005; 15; 5
31. Shirmer B.D., Scott-Jones R. Peptic ulcer disease. Invest. Radiol.; 1987; 22; 437-446.
32. Gelfand B.R., Guryanov V.A., Martinov A.N. et al. Prevention of stress damage to the gastrointestinal tract in patients in clinical conditions. Consilium medicum. Gastroenterology. Surgery [Profilaktika stress povrejdenii jeludochno kishechnogo trakta u bolnih v klinicheskikh sostoyaniyah. Consilium medicum. Gastroenterologiya. Hirurgiya] M.: 2005; 7; 6: 464-467

33. Belova O.L., Belova I.M. *The problem of 'associated' infectivity of H. pylori in the genesis of peptic ulcer disease. Russian journal of gastroenterology, hepatology and colo-proctology [Problema 'associirovannoi. infekcionnosti H.pylori v geneze yazvennoi bolezni. Rossiiskiy jurnal gastroenterologii, gepatologii koloproktologii]* M.: 2017; 27; 5: 14(40)

俄罗斯人群青少年特发性脊柱侧凸患者与健康人群UTS2R rs11654140 (T>C) 多态性分布的比较分析

**COMPARATIVE ANALYSIS OF THE UTS2R RS11654140 (T>C)
POLYMORPHISM DISTRIBUTION IN PATIENTS WITH
ADOLESCENT IDIOPATHIC SCOLIOSIS AND HEALTHY PEOPLE
IN THE RUSSIAN POPULATION**

Buslov Konstantin Grigor`evich

MD, Scientific Researcher of Molecular Genetics Laboratory, H.Turner National Medical Research Center for Children's Orthopedics and Trauma Surgery, Pushkin, Saint-Petersburg, Russia

Khalchitsky Sergei Egorovich

PhD, professor of Russian Academy Natural Science, Head of Molecular Genetics Laboratory, H.Turner National Medical Research Center for Children's Orthopedics and Trauma Surgery, Pushkin, Saint-Petersburg, Russia

Filippova Alexandra Nikolaevna

MD, Scientific Researcher of Department of Spine Pathology and Neurosurgery, H.Turner National Medical Research Center for Children's Orthopedics and Trauma Surgery, Pushkin, Saint-Petersburg, Russia

概括。背景：最近有报道称，UTS2R (rs11654140) 的多态性变异是中国人青少年特发性脊柱侧凸 (AIS) 易感性的潜在因素。有必要在不同人群中进行重复研究，以验证 UTS2R 在 AIS 中的作用。本研究的目的是确定俄罗斯患者 UTS2R rs11654140 与 AIS 之间的关联。

方法：使用 PCR-RFLP 方法对 129 名进行性 AIS 患者和 128 名正常对照进行单核苷酸变异 (SNV) UTS2R rs11654140 (T>C) 基因分型。卡方检验用于分析基因型和等位基因分布的组间比较。计算优势比 (OR) 以估计等位基因对 AIS 易感性的贡献。

结果：在基因型和等位基因分布方面，患者和对照组之间没有发现统计学上的显著差异。在患者和对照组的女性和男性亚组之间没有发现差异。稀有 C 等位基因的优势比 (OR) 分别为等位基因的 1.19 和载体等位基因的 1.1。罕见基因型 CC 与 TT+CT 基因型的 OR 为 0.54。

结论：在我们的研究中，UTS2R 基因的 SNV rs11654140 与俄罗斯人群的 AIS 易感性无关。

关键词：青少年特发性脊柱侧凸； UTS2R；单核苷酸变异；复制。

Summary. *Background: Polymorphic variant of UTS2R (rs11654140) have recently been reported as a potential contributor to the susceptibility of adolescent idiopathic scoliosis (AIS) in the Chinese Population. A replication study in the different population is warranted to validate the role of UTS2R in AIS. The aim of this study was to determine the association between UTS2R rs11654140 and AIS in the Russian patients.*

Methods: Single nucleotide variation (SNV) UTS2R rs11654140 (T>C) was genotyped in 129 patients with progressive AIS and 128 normal controls using PCR-RFLP method. The Chi-square test was used to analyze the inter-group comparison of the genotypes and alleles distribution. The Odds Ratio (OR) were calculated to estimate alleles contribution to the AIS susceptibility.

Results: No statistically significant differences were found between patients and controls for neither genotypes nor alleles distribution. No differences were found between subgroups of females and males in patients and controls. The odds ratio (OR) for the rare C allele was 1.19 for alleles and 1.1 for carrier alleles, respectively. The OR for rare genotype CC vs TT+CT genotypes was 0.54.

Conclusions: SNV rs11654140 of UTS2R gene is not associated with the susceptibility of AIS in the Russian population in our study.

Keywords: *Adolescent idiopathic scoliosis; UTS2R; Single nucleotide variation; Replication.*

Background

Idiopathic scoliosis (IS) is a common spinal condition affecting 2–4% of the children worldwide, occurring in otherwise completely healthy adolescents [1]. To benefit from the therapeutic strategy for patients with adolescent idiopathic scoliosis (AIS), it is important to have a better understanding of the etiopathogenesis of this disease. Numerous studies have been carried out to investigate the etiology of AIS while the conclusions remain unclear [2]. Usually, AIS is considered as a multifactorial disorder that involves interaction between genetic susceptibility, internal, and environmental factors [3, 4].

Many promising SNPs have been identified to predict the curve progression of AIS. However, conflicting results from replication studies and different ethnic groups hamper their reliability [5]. Commonly, ethnic differences and small sample size of the patients were considered to underlie the discrepancy between the original and the replication studies [6]. To overcome these limitations, an extremity comparison case-control study design was applied [7].

Polymorphic variant of UTS2R (rs11654140) have recently been reported as a potential contributor to the susceptibility of AIS in the Chinese Population [8]. A replication study in the different population is warranted to validate the role of UTS2R in AIS. The aim of this study was to determine the association between UTS2R rs11654140 and AIS in the Russian patients.

Materials and Methods

Subjects

A cohort of 129 AIS patients and 128 controls were included in the current study, under the approval of the local institutional Ethical Committee. All patients have a progressive form of disease and near all patients were with stage 3 or 4 in accordance with SRS criteria [9]. Patients having scoliosis secondary to known etiology were excluded from this study. Healthy subjects were recruited as normal controls after physical examination. Details of patients and control group are presented in Table 1.

Table 1.
Clinical characteristics of patients with progressive idiopathic scoliosis and controls

	Number	Age (mean age)	Stage of disease		
			Stage 2	Stage 3	Stage 4
Patients with IS	129 (100%)	6 — 20 (16.3)	1	21	107
Females	106 (82%)	6 — 20 (16.3)	1	18	87
Males	23 (18%)	15 — 19 (16.6)	-	3	20
Control group	128 (100%)	18 — 56 (30.3)	-	-	-
Females	87 (68%)	18 — 49 (26.1)	-	-	-
Males	41 (32%)	19 — 56 (34.3)	-	-	-

Genotyping

Genomic DNA was extracted from the blood with the commercial kit («Syn- tol», Moscow, Russia). Single nucleotide variant of UTS2R gene rs11654140 (T>C) was genotyped for all participants. A Polymerase Chain Reaction and Restriction Fragment Length Polymorphism (PCR-RFLP) analysis was used for genotyping assay. A PCR was performed in the 25 µl volume with 100 nM each forward (5'-CCCATCTCAGGGAGTGTCCA-3') and reverse (5'-GAGCTGTTGAGGGTTGCGTT-3') oligonucleotide primers, 0.5 U Taq polymerase Encyclo («Evrogen», Moscow, Russia) in appropriate PCR buffer with 3 mM MgCl₂, 1mM dNTPs and 1 µl of DNA solution. After the initial heating at 95° for 3 minutes, a 30 cycles of 15 seconds for denaturation at 95° and 30 seconds for coupled annealing-extension at 60° were repeated. An amplified 156 bp PCR

fragments were subsequently digested with restriction endonuclease Msp I («Si-bEnzyme», Novosibirsk, Russia) under conditions recommended by manufacturer, and separated in 10% PAG. Since the amplified PCR fragment includes two MspI restriction enzyme recognition sites, one polymorphic (rs11654140) and one non-polymorphic, which served as an internal control, the visible fragments after PAG separation were: 117 bp for the T-allele and 102 bp for the C-allele.

Statistical analysis

The online calculator Social Science Statistics (<https://www.socscistatistics.com/>) was used for data analysis. The Chi-square test was used to analyze the intergroup comparison of the genotypes and alleles distribution. The Odds Ratio (OR) were calculated to estimate genotypes and alleles contribution to the AIS susceptibility.

Results

The Chi-square test was used to analyze the comparison of genotypes and alleles in groups of patients with progressive IS and healthy controls, as well as for male and female patients and controls separately. The distribution of genotypes, alleles and allele carriers was not statistically different between patients and control groups, as well as between subgroups of males and females.

The odds ratio (OR) for the rare C allele was 1.19 for alleles and 1.1 for carrier alleles, respectively. The OR for rare genotype CC vs TT+CT genotypes was 0.54. Detailed information on the distribution of genotypes and alleles in the group of patients and the control group and statistical information is presented in Table 2.

Table 2.
UTS2R rs11654140 T>C genotyping data and statistical data

	Females			Males			General data, Females and Males			
	Patients (n=106)	Controls (n=87)	χ^2 p-value	Patients (n=23)	Controls (n=41)	χ^2 p-value	Patients (n=129)	Controls (n=128)	χ^2 p-value	OR
Genotypes										
TT	66 (62%)	51 (59%)	.49	8 (35%)	20 (49%)	.31	74 (57%)	71 (55%)	.39	1.16
TC	33 (31%)	26 (30%)		14 (61%)	17 (41%)		47 (36%)	43 (34%)		- *
CC	7 (7%)	10 (11%)		1 (4%)	4 (10%)		8 (6%)	14 (11%)		0.54
Alleles										
T	165 (78%)	128 (73%)	.33	30 (65%)	57 (70%)	.62	195 (76%)	185 (72%)	.39	1.19
C	47 (22%)	46 (27%)		16 (35%)	25 (30%)		63 (24%)	71 (28%)		
Allele carriers										
T-carriers	99 (71%)	77 (68%)	.60	22 (63%)	37 (64%)	.67	121 (69%)	114 (67%)	.68	1.1
C-carriers	40 (29%)	36 (32%)		15 (37%)	21 (36%)		55 (31%)	57 (33%)		

* OR values have been calculated for prevalent TT genotype vs TC+CC genotypes and for rare CC genotype vs CT+TT genotypes.

Discussion

Urotensins activate their receptor on slow-twitch muscle fibers of the dorsal somite; the contraction of these fibers likely results in straightening of the body axis. Mutation of the urotensin receptor resulted in severe scoliosis in adult zebrafish, closely mimicking the human disorder. These findings suggest that disruption of urotensin signaling by impaired CSF flow could be a critical etiological factor underlying the pathology of idiopathic scoliosis [10].

The recent study provides the linking the zebrafish data with AIS, discovered synonymous variants in UTS2R, the sole UII/Urp receptor in mammals, to be more prevalent in a cohort of 1200 AIS patients compared with a size-matched control cohort [8].

To determine the association between UTS2R rs11654140 and AIS in the Russian patients, an extremity comparison case-control study design was applied [7]. This powerful approach is based on the simple idea of comparing a group with severe clinical manifestations on the one hand and a control group without the risk of developing AIS on the other hand. In our opinion, this study design is justified to test promising genetic variants before conducting larger studies.

The rare C-allele SNV UTS2R rs11654140 was found in 24% of patients and 28% of the controls, which corresponds to the SNP database (<https://www.ncbi.nlm.nih.gov/snp/rs11654140>), but differs from the results in study Dai Z et al. (1.5 and 0.5%, respectively) [8], which may be due to population differences. Thus, the results obtained in our study do not confirm the role of the studied polymorphism in the development of scoliosis.

Conclusion

SNV rs11654140 of UTS2R gene is not associated with the susceptibility of AIS in the Russian population in our study.

References

1. Maqsood A, Frome DK, Gibly RF, Larson JE, Patel NM, Sarwark JF. *IS (Idiopathic Scoliosis) etiology: Multifactorial genetic research continues. A systematic review 1950 to 2017. J Orthop.* 2020; 21: 421-426. doi: 10.1016/j.jor.2020.08.005.
2. Peng Y, Wang SR, Qiu GX, Zhang JG, Zhuang QY. *Research progress on the etiology and pathogenesis of adolescent idiopathic scoliosis. Chin Med J (Engl).* 2020;133(4):483-493. doi: 10.1097/CM9.0000000000000652.
3. Tang NLS, Dobbs MB, Gurnett CA, Qiu Y, Lam TP, Cheng JCY, Hadley-Miller N. *A Decade in Review after Idiopathic Scoliosis Was First Called a Complex*

Trait-A Tribute to the Late Dr. Yves Cotrel for His Support in Studies of Etiology of Scoliosis. Genes (Basel). 2021;12(7):1033. doi: 10.3390/genes12071033.

4. Marya S, Tambe AD, Millner PA, Tsirikos AI. Adolescent idiopathic scoliosis: a review of aetiological theories of a multifactorial disease. *Bone Joint J. 2022;104-B(8):915-921. doi: 10.1302/0301-620X.104B8.BJJ-2021-1638.R1.*

5. Wang W, Chen T, Liu Y, Wang S, Yang N, Luo M. Predictive value of single-nucleotide polymorphisms in curve progression of adolescent idiopathic scoliosis. *Eur Spine J. 2022;31(9):2311-2325. doi: 10.1007/s00586-022-07213-y.*

6. Xia C, Xu L, Xue B, Sheng F, Qiu Y, Zhu Z. Rare variant of HSPG2 is not involved in the development of adolescent idiopathic scoliosis: evidence from a large-scale replication study. *BMC Musculoskelet Disord. 2019;20(1):24. doi: 10.1186/s12891-019-2402-x.*

7. Støer NC, Salim A, Bokenberger K, Karlsson I, Reilly M. Is the matched extreme case-control design more powerful than the nested case-control design? *Stat Methods Med Res. 2019;28(6):1911-1923. doi: 10.1177/0962280218778624.*

8. Dai Z, Wang Y, Wu Z, Feng Z, Liu Z, Qiu Y, Cheng JC, Xu L, Zhu Z. Novel Mutations in UTS2R are Associated with Adolescent Idiopathic Scoliosis in the Chinese Population. *Spine (Phila Pa 1976). 2021;46(5):E288-E293. doi: 10.1097/BRS.0000000000003786.*

9. Korbel K, Kozinoga M, Stoliński Ł, Kotwicki T. Scoliosis Research Society (SRS) Criteria and Society of Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT) 2008 Guidelines in Non-Operative Treatment of Idiopathic Scoliosis. *Pol Orthop Traumatol. 2014;79:118-22. PMID: 25066033.*

10. Zhang X, Jia S, Chen Z, Chong YL, Xie H, Feng D, Wu X, Song DZ, Roy S, Zhao C. Cilia-driven cerebrospinal fluid flow directs expression of urotensin neuropeptides to straighten the vertebrate body axis. *Nat Genet. 2018;50(12):1666-1673. doi: 10.1038/s41588-018-0260-3.*

血气成分参数在妊娠期高血压疾病鉴别诊断中的应用

THE USE OF BLOOD GAS COMPOSITION PARAMETERS IN THE DIFFERENTIAL DIAGNOSIS OF HYPERTENSIVE DISORDERS DURING PREGNANCY

Chupahin Ruslan Vladimirovich

Assistant of the Department

Saratov State Medical University named after V.I. Razumovsky

Khvorostukhina Natalia Fedorovna

Doctor of Medical Sciences, Full Professor, Head of the Department

Saratov State Medical University named after V.I. Razumovsky

Odnokozova Oksana Sergeevna

Candidate of Medical Sciences, Assistant of the Department

Saratov State Medical University named after V.I. Razumovsky

抽象的。介绍了 33 名孕妇在 22.0–37.0 周时测定毛细血管血液气体成分的结果。第 1 组包括没有妊娠并发症的健康女性 (n=13), 第 2 组 – 有妊娠期高血压 (n=15), 第 3 组 – 有中度先兆子痫 (n=7)。已经确定了高血压疾病中毛细血管血液中气体成分的变化: 在 pCO_2 增加的背景下, HCO_3^- 和 pO_2 减少。在第 3 组中检测到更明显的氧气状态障碍, 这导致早产和手术分娩的频率增加。对先兆子痫严重程度进行鉴别诊断的最有用的测试应该是氧分压 (pO_2) 水平的测量。

关键词: 产科; 怀孕; 血气成分; 妊娠高血压; 先兆子痫。

Abstract. The results of determining the gas composition of capillary blood in 33 pregnant women at 22.0–37.0 weeks are presented. Group 1 included healthy women with the absence of gestational complications (n=13), group 2 - with gestational hypertension (n=15), and group 3 – with moderate preeclampsia (n=7). Changes in the gas composition of capillary blood in hypertensive disorders have been established: decrease in HCO_3^- and pO_2 , against the background of an increase in pCO_2 . More pronounced oxygen status disorders have been detected in group 3, which led to an increase in the frequency of premature and operative labor. The most informative test for the differential diagnosis of the severity of preeclampsia should be considered the measurement of the level of oxygen partial pressure (pO_2).

Keywords: *obstetrics; pregnancy; blood gas composition; gestational hypertension; preeclampsia.*

The main objective of perinatal obstetrics is to decrease maternal and perinatal morbidity and mortality. At the same time, a significant value in the structure of the causes of maternal morbidity and mortality belongs to hypertensive disorders, which rate in Russia varies from 5 to 30%, averaging about 10% [1, 2, 3].

It is well known that the development of hypertensive disorders and preeclampsia (PE) in pregnant women is based on the damaging of microcirculation vessels [4]. At the same time, pregnancy is a state of prolonged physiological adaptation to the coexistence of two organisms – mother and fetus. And one of the conditions for the normal functioning of the body is the constancy of oxygen transport and the maintenance of acid-base state of the internal environment. Currently, it has been proven that microcirculation disorders in arterial hypertension lead to impaired metabolism in tissues and deterioration of oxygen utilization by tissues from the blood, which contributes to the development of tissue hypoxia and negatively affects the function of the complex uterus-placenta-fetus [3, 5, 6].

We believe that studying the parameters of the blood gas composition in a pregnant woman with hypertensive disorders will help to better realize the physiology of the “mother-placenta-fetus” system during the development of these gestational complications affecting the health of the fetus and mother.

Objective: to study the features of the gas composition of blood in pregnant women with hypertensive disorders

Materials and methods: A prospective, open, controlled, non-randomized research was conducted, which included pregnant women with a gestation period of 22.0 - 37.0 weeks who were treated in an obstetric hospital and were examined on the basis of a consultative and diagnostic department Perinatal Center (PC) Saratov City Clinical Hospital No. 8. The work was carried out with the permission of the Ethics Committee of the Saratov State Medical University named after V.I. Razumovsky and after receiving the voluntary informed consent of pregnant women for examination and treatment. Initially, 2 groups were identified. The 1st control group included 13 relatively healthy pregnant women in the absence of gestational complications. The main group consisted of 22 women who were hospitalized in the intensive care unit of the PC with a diagnosis of unspecified preeclampsia. Later, after examination and clarification of the diagnosis, the main group was divided into two – the 2nd group included 15 pregnant women with gestational arterial hypertension (GAH), the 3rd - with moderate preeclampsia (moderate PE n=7). The criteria for inclusion in the study were: gestation period from 22.0 up to 37.0 weeks, diagnosed unspecified preeclampsia, gestational hypertension, moderate preeclampsia, for the control group – the physiological

course of pregnancy and the absence of somatic pathology. Exclusion criteria: multiple pregnancy, gestation period less than 22 weeks, or more than 37.1 weeks, refusal of a woman to participate in the study.

Examination of all patients was carried out in accordance with federal standards (Order №1130n). Additionally, the gas composition (pH, pO₂, pCO₂, HCO₃-act) of capillary blood of pregnant women (upon admission, before the start of therapeutic measures) was determined on the device RAPIDLAB 1265.

Statistical analysis was carried out using software “Microsoft Office Excel” and “Statistic 7.0”. To determine the differences between the two average values of the parameters, the Student’s t-test was used, the Fisher’s χ^2 criterion was used as qualitative (differences at $p < 0.05$ were considered statistically significant).

The results of the study and their discussion: The results of our study showed that pregnant women of all groups were comparable in age, while women aged 25 to 35 years significantly prevailed in all groups (Table 1).

Table 1
General characteristics of pregnant groups.

Parameters	1 st group (n=13)		2 nd group (n=15)		3 rd group (n=7)		p ¹⁻²	p ¹⁻³	p ²⁻³
	n	%	n	%	n	%			
Under 25 y.o.	2	15,4	1	6,7	0	0,0	0,45	0,28	0,49
From 25 to 35 y.o.	9	69,2	11	73,3	4	57,1	0,81	0,59	0,45
Over 35 y.o.	2	15,4	3	20	3	42,9	0,75	0,18	0,26
Primiparous	8	61,5	6	40,0	3	42,9	0,25	0,42	0,90
Multiparous	5	38,5	9	60,0	4	57,1	0,25	0,42	0,90

In addition, the proportion of primiparous and multiparous women in the groups also did not have significant differences (table 1).

At the same time, the incidence of genital pathology in history in pregnant women with hypertensive disorders significantly exceeded those of the 1st control group (Fig. 1).

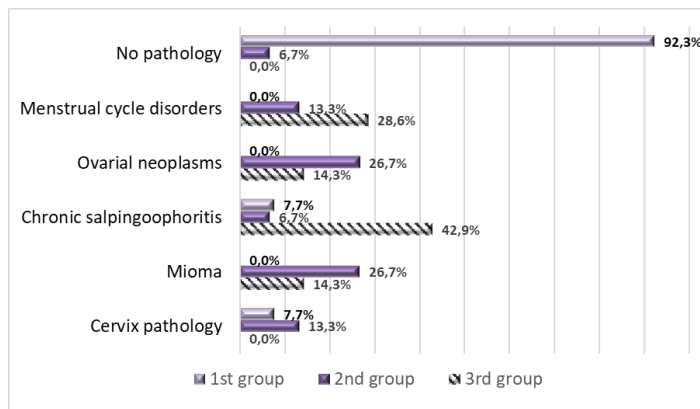


Figure 1. Features of gynecological anamnesis in groups.

A similar situation was traced when studying the frequency of concomitant somatic pathology in pregnant women in groups. Among extragenital diseases in pregnant women of the 2nd and 3rd groups, chronic hypertension, gastrointestinal tract diseases and obesity prevailed (Fig. 2).

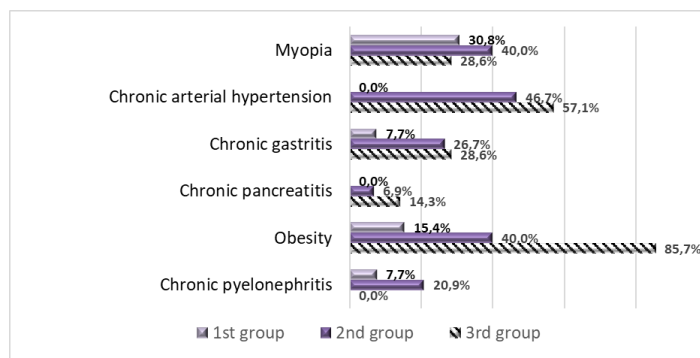


Figure 2. Features of somatic pathology in groups.

The data obtained is consistent with the opinion of many scientists about the considerable importance of the identified concomitant diseases in the development of hypertensive disorders during pregnancy [7, 8, 9].

Analysis and interpretation of the results of determining the gas composition of capillary blood of pregnant women in the groups revealed changes in the acid-base state of blood in GAH and moderate PE, which were manifested by a decrease in the content of true bicarbonate ($\text{HCO}_3\text{-act}$) in comparison with the control param-

eters of group 1 ($p^{1-2} = 0,02$; $p^{1-3} < 0,001$), which may indicate the risk of developing metabolic acidosis in such patients (table 2). At the same time, the pH level in pregnant women did not have significant intergroup differences.

Table 2
Results of determining the gas composition of capillary blood

Parameters	1 st group (n=13)	2 nd group (n=15)	3 rd group (n=7)	p^{1-2}	p^{1-3}	p^{2-3}
	M (SD)	M (SD)	M (SD)			
pH	7,38 (0,01)	7,35 (0,01)	7,38 (0,02)	0,05	1,0	0,20
HCO ₃ -act (mmol/L)	29,98 (0,91)	18,51 (0,3)	17,94 (0,21)	0,02	< 0,001	0,14
pCO ₂ (mm.Hg.)	37,88 (0,67)	38,77 (0,85)	40,18 (0,61)	0,04	0,02	0,19
pO ₂ (mm.Hg.)	75,32 (0,81)	70,71 (0,82)	65,18 (1,15)	0,03	< 0,001	0,001

However, the average values of the parameters of partial pressure of oxygen and carbon dioxide in the capillary blood of pregnant women of the 2nd and 3rd groups before the start of therapeutic measures approached the boundaries of hypoxemia and hypercapnia, and more significant changes were found when comparing the average values of the level of pO₂ in pregnant women with moderate PE ($p^{1-3} < 0,001$; $p^{2-3} = 0,001$).

Further dynamic observation of pregnant women revealed an increase in the frequency of early termination of gestation in group 3 ($p^{1-3} < 0,001$; $p^{2-3} = 0,01$) – up to 71.4% in total (Fig. 3).

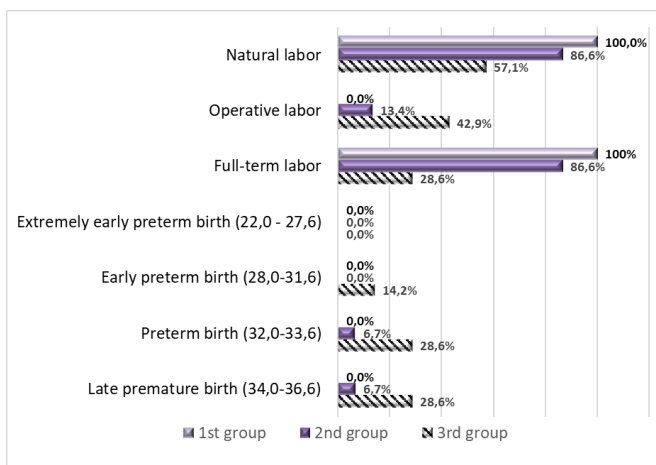


Figure 3. Terms and methods of delivery of pregnant women in groups.

Despite the small number of patients in group 3 ($n=7$), the main causes of preterm labor in moderate PE were: spontaneous development of labor activity ($n=2$), diagnostic criteria for severe PE ($n=2$) and premature detachment of the normally located placenta ($n=1$), which, in turn, it contributed to an increase in the frequency of cesarean section in this group to 42.9% ($p^{1-3} = 0,01$) (Fig. 3).

The results of our work do not contradict previously published studies, which clearly demonstrate the importance of oxygen transport system disorders in the pathogenesis of various pregnancy complications [10, 11].

Conclusions: 1. In pregnant women with hypertensive disorders, changes in the gas composition of capillary blood were found: a decrease in true bicarbonate ($\text{HCO}_3\text{-act}$) and oxygen partial pressure (pO_2) against the background of an increase in carbon dioxide partial pressure (pCO_2), which reflect a tendency to develop metabolic acidosis and respiratory alkalosis in this pathology. More pronounced oxygen status disorders were detected in pregnant women with moderate preeclampsia, which led to an increase in the frequency of premature and operative labor in this pathology of gestation.

2. Determination of the gas composition of capillary blood can be used as an additional criterion for a comprehensive assessment of the severity of hypertensive disorders during pregnancy. At the same time, the most informative test for the differential diagnosis of the severity of preeclampsia should be considered the measurement of the level of oxygen partial pressure (pO_2).

References

1. *Preeclampsia. Eclampsia. Edema, proteinuria and hypertensive disorders during pregnancy, childbirth and the postpartum period: wedge. recommendations of the Ministry of Health of the Russian Federation* / Z.S. Khodzhaeva, R.G. Shmakov, G.M. Savelyeva [et al.] – Moscow: Ministry of Health of the Russian Federation, 2021. – 79 p.
2. *Hypertensive conditions: features of the course of pregnancy and perinatal outcomes* / S.V. Kinzhalova, R.A. Makarov, N.B. Davydenko [et al.] // *Treatment and prevention*. – 2018. – Vol. 8, No. 3. – pp. 40-48.
3. *The influence of basic hypotensive therapy on the state of the fetoplacental complex and pregnancy outcomes in chronic arterial hypertension* / N.F. Khvorostukhina, I.Y. Shlyakhova, N.N. Stepanova [et al.] // *Modern problems of science and education*. – 2015. – No. 6 [electronic resource] - Access mode. - URL: <https://science-education.ru/ru/article/view?id=23097> (accessed: 05/29/2022).
4. *Prognosis and laboratory diagnostics of hypertensive disorders during pregnancy* / A.A. Balushkina, V.L. Tyutyunnik, N.E. Kan [et al.] // *RMZH. Mother and child*. – 2019. – Vol. 2, No. 2. – pp. 89-94.

5. *Oxygen transport in pregnant women with hypertensive disorders* / S.V. Kinzhalova, L.A. Pestryaeva, R.A. Makarov [et al.] // *Ural Medical Journal*. – 2009. – No. 10. – p. 74.

6. *Expectant management of severe preterm preeclampsia: a comparison of maternal and fetal indications for delivery* / S.S. Mooney, R.M. Lee, S. Tong, F.C. Brownfoot // *J. Matern. Fetal. Neonatal. Med.* – 2016. – Vol. 29(23). – p. 3821-6. doi:10.3109/14767058.2016.1147555.

7. *Key risk factors for the development of preeclampsia in pregnant women with arterial hypertension* / I.A. Danshina, V.V. Dankina, A.A. Chistyakov, K.V. Dankin // *Bulletin of Hygiene and Epidemiology*. – 2019. – Vol. 23, No. 4. – pp. 389-392.

8. *Metabolic features of patients with late manifestation of preeclampsia* / N.Yu. Katkova, K.B. Pokusaeva, I.M. Bezrukova [et al.] // *Medical opponent*. – 2020. – № 3 (11). – Pp. 32-35.

9. *Spradley F.T., Play A.C., Granger J.P. Increased risk for the development of preeclampsia in obese pregnancies: weighing in on the mechanisms* // *Am. J. Physiol. Regul. Integr. Comp. Physiol.* – 2015. – Vol. 309(11). – R1326-43. doi:10.1152/ajpregu.00178.2015.

10. *The influence of a genetically determined violation of energy metabolism on lipid metabolism and blood gas homeostasis during pregnancy complicated by fetal growth retardation syndrome* / S.A. Azhibekov, N.V. Putilova, T.B. [et al.] // *Problems of reproduction*. – 2018. – Vol. 24, No. 1. – pp. 71-76.

11. *Parameters of the blood gas composition in hypertensive disorders in pregnant women* / N.F. Khvorostukhina, R.V. Chupahin, D.A. Novichkov [et al.] / *In the collection: Materials of the All-Army scientific and practical conference dedicated to the 180th anniversary of the Clinic of Obstetrics and Gynecology of the Military Medical Academy named after S. M. Kirov* / Under scientific. ed. by A. A. Schmidt, I. S. Zakharova – St. Petersburg: SpetsLit, 2022. – pp. 122-129.

DOI 10.34660/INF.2022.52.54.160

心脏粘液瘤临床病例
CLINICAL CASE OF CARDIAC MYXOMA

Al-Marwani A.M.

student

*N.P. Ogarev National Research Mordovia State University,
Saransk, Russia*

Kurkina Nadezhda Viktorovna

Candidate of Medical Sciences, Associate Professor

*N.P. Ogarev National Research Mordovia State University,
Saransk, Russia*

抽象的。心脏粘液瘤是最常见的心脏肿瘤。本病例描述了一名成人右心室粘液瘤，两年后出现大块复发。一名 19 岁男性，右心室粘液瘤，患者年轻时跑步困难，发展为上楼行走受限。患者因呼吸困难和不适到医院就诊。患者的祖父认为他死于猝死。检查包括通过听诊对心脏和肺部进行体格检查，通过超声心动图和 CMR 进行仪器检查，以及通过一般血液检查进行实验室检查。将所有仪器和实验室结果与正常范围进行比较。听诊体格检查示三尖瓣反流杂音。超声心动图显示右心室有大肿块，怀疑右心房有小肿块。CMR 显示在右心室可见一个边界光滑的多分叶肿块，大小为 5.5 x 3.8 厘米，是可移动的肿块，侵犯三尖瓣（特别是前叶和后叶）并在收缩期伸入右心室流出道造成部分 RVOT 阻塞，部分侵犯 SVC。右心室扩张，右心房扩张。左心室和心房大小正常。在瓣膜上有中度三尖瓣反流。验血显示贫血。患者接受了右心室大块切除手术和组织瓣置换三尖瓣。年轻人目前的状态非常好。

关键词：粘液瘤，超声心动图，心脏磁共振，右心室流出道。

Abstract. *Cardiac myxoma is the most common cardiac neoplasm. The present case describes a Myxoma in the right ventricle of an adult with a large mass recurrence after two years. A 19-Years-old male with right ventricle Myxoma, The patient had difficulty running in younger age and developed to be a limited walking upstairs. The patient attended to hospital with difficulty breathing and malaise. The patient's grandfather believed that he died from sudden death. The examinations involved physical examination of the heart and lungs by auscultation, instrumental by Echocardiography and CMR , and laboratory by General blood test. All instrumental and laboratory results were compared with the normal ranges. The results on physical examination on auscultation revealed murmur of*

tricuspid regurgitation. The echocardiography showed a large mass in the right ventricle and suspected a small mass in the right atrium. CMR showed a multi-lobulated mass with smooth borders is seen in the right ventricle with measure of 5.5 x 3.8 cm , it is mobile mass and encroaches on tricuspid valve(Specially anterior and posterior leaflets) and protrudes into the outflow of right ventricle during systole causing partial RVOT obstruction, partial encroachment on SVC. The right ventricle is dilated and also the right atrium is dilated. The left ventricle and atrium are in normal size. On valves there was moderate tricuspid regurgitation. The blood test showed anemia. The patient was treated by mass resection surgery in the right ventricle and replacement of the Tricuspid valve by Tissue Valve . The current condition of the young adult is excellent.

Keywords: *Myxoma, Echocardiography, Cardiac magnetic resonance, Right ventricle outflow tract.*

Introduction

Cardiac myxoma (CM) is the most frequent primary benign cardiac tumor. It is slowly growing neoplasm of endocardial origin . Because of the low occurrence of CM, with 0.5-1 cases per 1,000,000 people per year, some reports showed that the ratio between women and men is 3:1, and because of its various clinical presentation, identification of CM has got a unique diagnostic challenge in clinical practice. However a diagnostic tactic to patient with CM is based on medical history, clinical examination, blood test results, and echocardiographic findings. Computed tomography (CT) and magnetic resonance imaging (MRI) of chest or heart help with the differential diagnosis, which differs CM from other cardiac tumors and masses. The main treatment in patient with CM is surgical excision. CM recurrence after surgical removal is mostly observed in people with familial and complex forms of the condition. To identifying vague CM in asymptomatic and with family history patients genetic analysis gives a good opportunity for identification.

Case Presentation

In 2020, a 19-years-old male brought by his father to Al-Thourah Hospital in Sana'a, Yemen seeking a help with complaints of his chronic malaise and episodes of shortness of breathing. According to the patient, before 2 years he started to feel lethargy and weakness, he was facing a real problem walking up to the hill since his village is in the top of the mountain. he didn't inform non of his family members about his condition. In the begging of 2020 his condition got worsened when he wasn't able to walk up to the hill and couldn't climb more than 5 stairs. The grandfather of the patient died from sudden death. During the day of his first presence in hospital , physical examination and blood test were performed. By auscultation systolic murmur was heard, on blood test showed anemia. The patient then was transformed to cardiologist and transthoracic echocardiogram was

performed, on echocardiogram showed mass in the right ventricle on fig.1 . The cardiologist decided to do emergent open heart surgery for excision of the mass due to the increased risk of systemic embolization or tricuspid valve obstruction. The myxoma was excised under total cardiopulmonary bypass fig.1 , The mass was taken to Morphopathology laboratory where it was confirmed to be a myxoma. The postsurgical echocardiography noted the absence of the tumoral mass. Post-operation doctor prescribed antibiotic, antihypertensive, antiplatelet , diuretic and symptomatic drugs. Patient followed up examinations with cardiologist every 3 months, after 15 months of visitation, patient stopped going to doctor for 10 months.

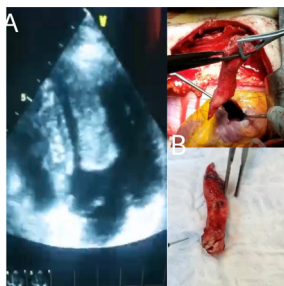


Figure 1. (a) the mass attached to the free wall mainly the apex, (b) mass excision and examination.

The patient later went to his village and then started to feel weakness, malaise and shortness of breathing accompanied by chest pain. He was sent back to cardiologist and examined by echocardiogram, the result showed recurrence of the mass in the right ventricle with measure of 5.5 x 3.8 cm and small mass in the right atrium with encroachment on superior vena cava as shown in fig.2 . Due to the recurrence of the mass with larger size and serious risk of embolization, the decision was made to do the operation abroad.

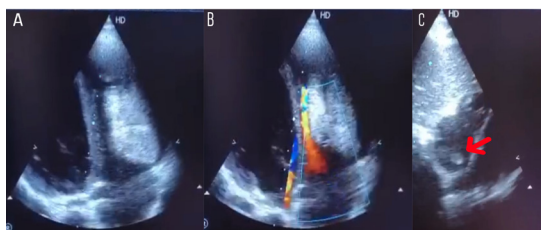


Figure 2. (a,b) shows big mass in the right ventricle with measure of 5.5 x 3.8 cm attached to RV free wall. (c) shows small mass in the right atrium with extension to the SVC.

The further procedure was examination by cardiovascular magnetic resonance(CMR) to investigate heart structures measurement fig.3, heart functions fig.4-5, mass structure and delayed hyperenhancement findings. The CMR was done by contrast injection Dotarem, intravenous antecubital vein, 9 cc.

Structure	Measurement	Normal range
Left atrium	26mm	21-39mm
Main pulmonary artery(MPA)	25mm	16-33mm
Left pulmonary artery(LPA)	13mm	12-23mm
Right pulmonary artery(RPA)	12 mm	12-23mm
Ascending aorta	21 mm	22-38mm
Descending aorta	13 mm	14-26mm
Inerventricular septum(IVS)	7 mm	6-12mm
Left ventricular end-diastolic diameter	49 mm	37-54mm
Left ventricular lateral wall	6 mm	5-11mm

Figure 3. Heart, aortic and pulmonary arteries structure measurements

Left ventricular ejection fraction(LVEF)	56%	Normal=56-78%
Left ventricular stroke volume(LVSV)	66 ml	Normal=51-133 ml
Left ventricular end-diastolic volume LVED/BSA	199 ml 85 ml/m²	Normal=82-174 ml N=51-95 ml/m ²

Figure 4. left ventricular function (BSA=1.4 m²)

Right ventricular ejection fraction(RVEF)	38%	Normal=47-74%
Right ventricular stroke volume(RVSV)	68 ml	Normal=52-138ml
Right ventricular end-diastolic RVEDV/BSA	178 127 ml/m²	Normal=125-237ml N=67-111 ml/m ²

Figure 5. right ventricular function

Mass structure showed multi-lobulated large mass with smooth borders is seen within theright ventricle (RV). It is attached to RV free wall by a thin stalk. It measures 5.5 x 3.8 cm. It is mobile mass, and it encroaches on the tricuspid valve

(specially anterior & posterior leaflets) and protrudes into the outflow of right ventricle during systole causing partial RVOT obstruction. No invasion of adjacent structure is detected. Partial encroachment on SVC is noticed. The right ventricle is dilated, the right atrium is also dilated, moderate tricuspid regurgitation (Regurgitation fraction=33% Q-flow). Functional findings showed right ventricular systolic moderate impairment. Delayed hyperenhancement images findings showed heterogeneous mass appearance. CMR images Fig.6 .

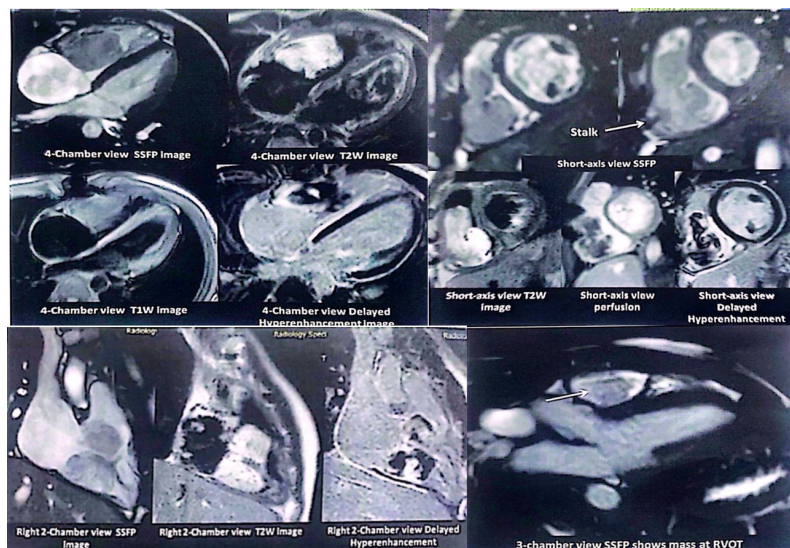


Figure 6. CMR shows mass in RV.

The further procedures before the operation were examination by general blood test and showed anemia, serum creatinine test(CREA jaffe Gen2 comp) test was done to exclude chronic kidney disease and maybe paraneoplastic nephropathy due to the decreased blood supply to the kidneys. the serum test creatinine showed normal range. Other laboratory analysis, Biochemical test of glycosylated/Hb, blood urea, serum uric acid, serum bilirubin and serum glutamic oxaloacetic transaminase(GOT). Serological test of antistreptolysin O titer (ASO), and C-reactive protein test (CRP). Blood test of ESR, HBs Ag, HCV Ab, HIV, blood group and rhesus factor. the results were all in normal range. Operation surgery performed by mass excision and tricuspid valve replacement by tissue valve. Patient after successful open heart surgery hospitalized for 5 day with management by antibiotic, gastroprotective, diuretic and analgesic drugs for 10 days, Antiplatelet and Antihypertensive drugs from the day after operation and continued

for 102 days. Examination by cardiologist every 3 months. Patient 3 months after surgery performed echocardiogram examination, the results showed free right ventricular and free right atrium, no regurgitation of the new tissue valve. Tricuspid valve gradient was normal fig.7 .

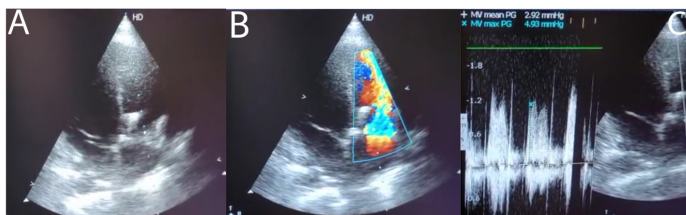


Figure 7. (a,b) shows the free right atrium and ventricle, and normal outflow tract, (c) normal tricuspid valve gradient with 2.92mmHg .

Discussion

Cardiac myxoma is an intracavitary neoplasm attached to the endocardium and is the most common adult primary heart neoplasm. These are usually seen in the atria with the majority (75%) occurring in the left atrium and less commonly in the right atrium (20%). Rarely myxomas may be right ventricular, biatrial, left ventricular, or multiple locations. Further on, cardiac myxoma in RVOT remains a relatively rare entity, with only 30 cases reported in the past decade [1].

The age group of myxoma varies widely from 15 to 80 years with a mean age of approximately 50 years. Patients can present with cardiac obstructive symptoms, embolic phenomenon, and constitutional symptoms of fever, malaise, weight loss, anemia, and elevated erythrocyte sedimentation rate. RVOT tumors can result in syncope, dysrhythmia, pulmonary emboli, valvular dysfunction, and even sudden death. Acute presentation, either in the form of acute right ventricular failure, or cardiac arrest may occur. The probability of cardiac myxomas to embolize is likely related to the tumor morphology. For example, firm fibrous tumors are less likely to embolize than friable myxomas. Approximately 20% of patients with myxomas are asymptomatic (irrespective of intracardiac location), and the tumors are discovered only incidentally or at post-mortem examination [2]. The histologic features are heterogeneous with the tumor cells assuming rings, nests, and linear syncytia and scattered intermittently with variable amount of stroma. Secondary features of hemorrhage, hemosiderin, thrombus, and calcification are commonly visualized [2,3].

CT imaging characteristics of myxoma include round to ovoid filling defect simulating mass with lobular contour and iso to hypo attenuation relative to the myocardium. Site of attachment of cardiac myxoma is not always discernible on

CT, especially those which have multiple attachments and of large myxomas that completely or near completely fill the cardiac chamber.

Cardiac MRI is a noninvasive modality to evaluate cardiac function and can affect the diagnostic or therapeutic plan. In addition, cardiac MRI provides critical information regarding interaction of the tumor with valves and about hemodynamic compromise with prolapse of tumor into the pulmonary artery. Thus, cardiac MRI plays an important versatile role and is of greatest value when other imaging findings are equivocal and the lesion has atypical location and appearance.

MR characteristics of tumor depends on the constitution of the myxoma and secondary changes. Heterogeneous signal intensity correlates with the presence of hemorrhage and blood degradation products, fibrosis, cystic changes, and calcification.

Gadolinium enhancement of the myxomas is useful in differentiating them from non-enhancing thrombus [4].

MRI accurately confirms the point of attachment to the endocardium with multiplanar imaging and cine MR sequences. Cine SSFP sequences show well defined hypointense mass with mobility during cardiac systole, demonstrating prolapse across the valve.

In our case, MRI was useful to confirm the location of the tumor in RVOT, mobility during cardiac systole, and for tissue characterization. RV myxoma warrants urgent operative management of surgical resection. The stalk is resected along with the stalk attachment site. Surgical mortality is low with excellent long-term survival. The operative mortality is reported to be within 5%, the rate is increased with ventricular myxomas. The overall rate of myxoma recurrence post resection was reported to be 13%, with recurrence being highly associated with younger age [5]. However, literature specifically delineating the prognosis and recurrence rate of RV myxomas was not available.

Conclusion

In conclusion the CM is still a real clinical practice challenge to diagnose due to its variable clinical symptoms. The 19-years-old male has suffered from malaise and weakness since he was in younger age and condition progressed to be limited upstairs walking. The right ventricle mass was removed, after 2 years the mass returned and second opened heart surgery was performed. The current condition of the young adult is excellent. The repeated examination with cardiologist by echocardiogram is necessary for monitoring of individuals who have past myxoma excision surgery. Genetic analysis gives a good opportunity in young individuals with family history in identifying vague cardiac myxoma.

Reference

1. Lacey BW, Lin A. Radiologic evaluation of right ventricular outflow tract myxomas. *Tex Heart Inst J* 2013;40:68–70.
2. Grebenc ML, Rosado-de-christenson ML, Green CE, Burke AP, Galvin JR. Cardiac myxoma: imaging features in 83 patients. *Radiographics* 2002;22:673–89.
3. Sparrow PJ, Kurian JB, Jones TR, Sivananthan MU. MR imaging of cardiac tumors. *Radiographics* 2005;25:1255–76.
4. Gomes AS, Lois JF, Child JS, Brown K, Batra P. Cardiac tumors and thrombus: evaluation with MR imaging. *Am J Roentgenol* 1987;149:895–9.
5. Elbardissi AW, Dearani JA, Daly RC, Mullany CJ, Orszulak TA, Puga FJ, et al. Survival after resection of primary cardiac tumors: a 48-year experience. *Circulation* 2008;118(14 Suppl):S7–15.

DOI 10.34660/INF.2022.17.12.161

龙胆果中花青素和熊果酸含量的研究
**STUDY OF THE CONTENT OF ANTHACYANINS AND URSOLIC
ACID IN EMPETRUM NIGRUM BERRIES**

Stoyan Viktoriya Alexandrovna

Student

*Pyatigorsk Medical and Pharmaceutical Institute, branch of the
Volgograd State Medical University, Russia, Pyatigorsk*

Butenko Lyudmila Ivanovna

Candidate of Chemical Sciences, Associate Professor

*Pyatigorsk Medical and Pharmaceutical Institute, branch of the
Volgograd State Medical University, Russia, Pyatigorsk*

Podgornaya Zhanna Valerievna

Deputy director, Candidate of Pharmaceutical Sciences

Medifarm LLC, Moscow, Russia

抽象的。蔓越莓植物分布在整个北半球，被许多土著人民的饮食所包含。该植物不是药典，但广泛用于北方、西伯利亚和远东人民的民间医药。在俄罗斯境内，分布于北极、东西伯利亚和远东。它的自然资源非常丰富。浆果的柔软部分可食用，它们很好地解渴，但糖和酸的含量低，使它们的味道相当平淡。本研究的目的是确定马加丹州生长的 *Empetrum nigrum* – Black Shiksha 浆果中花青素和熊果酸的定量含量。Shiksha 浆果中熊果酸的含量是通过基于与浓硫酸反应的分光光度法进行的，然后测量 *rasivor* 的光密度。研究结果表明，在马加丹州采集的黑什克沙中熊果酸的含量为 0.35%。花青素的测定按照药典文章进行。经研究发现，黑石竹中的花青素含量为1.58%。

基于以上研究，我们可以得出结论，黑石竹是研究主要生物活性化合物的一种很有前景的原料。

关键词：红莓，Shiksha，花青素，熊果酸，分光光度法，比较吸收。

Abstract. The crowberry plant, distributed throughout the Northern Hemisphere, is included in the diet of many indigenous peoples. The plant is not a pharmacopoeial, but is widely used in folk medicine of the peoples of the North, Siberia and the Far East. On the territory of Russia, it is distributed in the Arctic, Western and Eastern Siberia, and the Far East. Its natural resources are enormous. The soft part of the berries is edible, they quench their thirst well, but the low content of sugars and acids makes them taste rather bland. The purpose of this study

is to determine the quantitative content of anthacyanins and ursolic acid in the berries of *Empetrum nigrum* - **Black Shiksha** growing in the Magadan Oblast. The content of ursolic acid in Shiksha berries was carried out by a spectrophotometric method based on the reaction with concentrated sulfuric acid, followed by measurement of the optical density of the rasivor. As a result of the research, it was found that the content of ursolic acid in Black Shiksha, collected in the Magadan Oblast, is 0.35%. The determination of anthocyanins was carried out according to the Pharmacopoeia article. As a result of the research, it was found that the content of anthocyanins in Black Shiksha is 1.58%.

Based on the above studies, we can conclude that black Shiksha is a promising raw material for studying the main biologically active compounds.

Keywords: Crowberry, Shiksha, anthocyanins, ursolic acid, spectrophotometry, specific absorption.

The crowberry common throughout the Northern Hemisphere, is included in the diet of many indigenous peoples. In folk medicine, decoctions and infusions of the aerial part of the plant are used to treat stomach diseases and diarrhea. Crowberry juice was used to treat kidney diseases. In addition, in Russian folk medicine, decoctions of leaves and shoots were used for metabolic disorders, overwork, as an antiscorbutic, as well as for the treatment of epilepsy and paralysis. This effective remedy helps to overcome overwork and insomnia. Shiksha is also prescribed for edema, dropsy, problems with urination, paralysis, convulsions, gastritis, metabolic disorders of the body, diarrhea, colitis. Shiksha is known to be used in Tibetan medicine to treat diseases of the liver and kidneys (internal use); acne, ulcers, wounds, rashes (external use).

Just as we have, the plant is recommended as an effective remedy for restoring the nervous system, treating neuropsychiatric diseases, sleep disorders, epilepsy, and schizophrenia.

Crowberry (lat. *Empetrum*) is a genus of evergreen low-growing creeping shrubs with needle-like leaves and inconspicuous flowers (Heather family, Heather order, Dicotyledonous class). The name of the genus comes from the Greek words en "on" and petros "stone", which is associated with the places where plants grow.

People call crowberry bearberry, bagnovka, crowberry (for the color of the berries), drunkenness, ssykha (for the diuretic effect of berries), black grass, shiksha, ssykha, psycho.

In the scientific literature, a description of crowberry black is found in the famous Deutschlands Flora in Abbildungen by the founder of the Nuremberg Society for Natural History, German botanist and engraver Jacob Sturm (German Jacob Sturm, 1771-1848) (Fig. 1) [1].



Figure 1. Crowberry black. Botanical illustration by Jakob Sturm from “Deutschlands Flora in Abbildungen” book (1796).

The plant is not a pharmacopoeial, but is widely used in folk medicine of the peoples of the North, Siberia and the Far East. On the territory of Russia, it is distributed in the Arctic, Western and Eastern Siberia, and the Far East. Its natural resources are enormous. The soft part of the berries is edible, they quench the thirst well, but the low content of sugars and acids makes them taste rather bland. Description of shiksha (Fig. 2), as a medicinal plant used in folk medicine, is included in the Atlas of Medicinal Plants of Yakutia



Figure 2. Crowberry shiksha from the “Atlas of Medicinal Plants of Yakutia” book.

The chemical composition of shiksha is diverse. Crowberry contains triterpene saponins, flavonoids (quercetin, kaempferol, rutin), tannins, essential oils, resins, coumarins, benzoic and acetic acids, anthocyanins, vitamin C, carotene, various trace elements, including manganese, sugars.

The purpose of this study is to determine the quantitative content of anthacyanins and ursolic acid in the berries of *Empetrum nigrum* - **Black Shiksha** growing in the Magadan Oblast.

Shiksha berries were collected at the end of October in the area of the “Mask of Sorrow” memorial in the Magadan Oblast. The raw material was frozen at -18°C for storage (Figure 3).

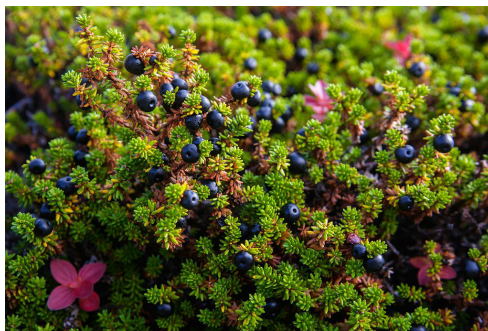


Figure 3. Appearance of *Empetrum nigrum* growing on the territory of the Magadan Oblast.

Northern berries are characterized by the fact that they are stored for a long time (within a year), this is facilitated by the chemical composition of the berries, namely, due to the fact that they contain organic acids in their composition. Further, qualitative reactions (foaming in acidic and alkaline environments; red staining with the Liebermann-Burchard reagent) proved the presence of saponins.

The isolation of ursolic acid was carried out from a dry extract obtained from an alcohol-water extract of the native raw material of shiksha berries. The dry extract was treated with a mixture of ethyl alcohol and 10% sodium hydroxide solution in a ratio of = 9: 1. The resulting extracts were acidified with a solution of HCl to pH = 7. After a few days, crystals of ursolic acid precipitated.

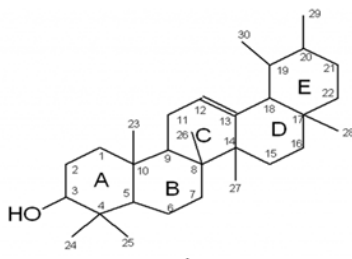


Figure 4. Ursolic acid formula.

The content of ursolic acid in Shiksha berries was measured by the spectrophotometric method [3], based on the reaction with concentrated sulfuric acid, followed by the measurement of optical density and the use of the specific absorption index of ursolic acid at 310 nm in conc. sulfuric acid is 333.6.

$$X = \frac{D * V_o * V_1 * 100}{E_{1\text{ cm}}^{1\%} * m * V_2 * (100 - W)}$$

Where D is the optical density of the test solution;
 V_o – VOLUME OF EXTRAGENT, ML;
 V_1 is the volume of the analytical solution, ml;
 $E_{1\text{ cm}}^{1\%}$ is the specific absorption index of ursolic acid at 310 nm in concentrated sulfuric acid, which is 331.6;
 m is the mass of the extract;
 V_2 is the sample volume taken for analysis. ml;
 W is the weight loss of the extract during drying, %.

As a result of the research, it was found that the content of ursolic acid in Black Shiksha, collected in the Magadan Oblast, is 0.35%.

Local residents, where shiksha grows, use cherry dye to dye wool from its berries. This fact indicates the content of anthocyanins in a high concentration, which allows shiksha berries to be used as a natural dye.

Anthocyanins give color to flower petals, fruits a variety of colors of brown, red, orange, blue and purple. Interestingly, plants containing a large amount of anthocyanin have an increased resistance to air pollution by acid gases from industrial enterprises. Entering the human body with fruits and vegetables, anthocyanins maintain the normal state of blood pressure and blood vessels, preventing internal hemorrhages. They can exist in various forms: oxonium cation, carbonium cation. Forming complexes with radioactive elements, anthocyanins contribute to their rapid removal from the body. In addition, these pigments can improve vision.

We have studied the UV spectra of the extraction with an aqueous solution of 1% hydrochloric acid of crowberry and cornflower. As can be seen from the figures, the character of the curve and the peaks in the spectra coincide. As an analytical wavelength, $\lambda = 515$ nm is proposed, corresponding to the absorption of cyanidin-3,5-diglycoside.

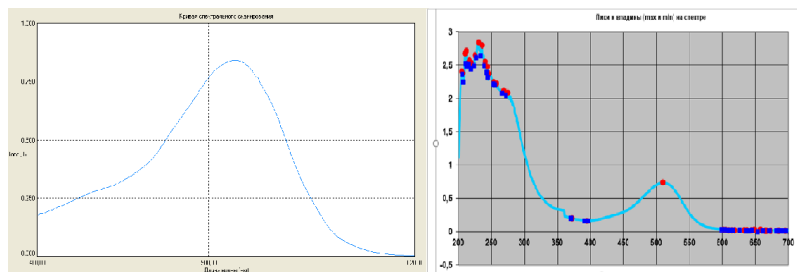


Figure 2. UV spectrum of Shiksha black and Cornflower blue in alcohol.

Pharmacopoeia article [4] recommends the determination of anthocyanins spectrophotometrically using the specific absorption of cyanidin - 3,5 - diglycoside = 453 according to the above formula:

$$X = \frac{D * 250 * 100}{453 * m * (100 - W)}$$

where **D** is the optical density of the test solution;

453 - specific absorption rate of cyanidin-3,5-diglycoside in 1% hydrochloric acid solution;

m is the mass of raw materials in grams;

W - weight loss during drying of raw materials in percent.

As a result of the research, it was found that the content of anthocyanins in Black Shiksha is 1.58%.

Based on the above studies, we can conclude that black Shiksha is a promising raw material for studying the main biologically active compounds.

References

1. <http://www.sil.si.edu/DigitalCollections/NHRareBooks/Sturm/sturm-introduction.htm>
2. *Atlas of medicinal plants of Yakutia. Vol. 2: Medicinal plants used in folk medicine* / Edited by B.I. Ivanov. – Yakutsk, 2005. – p.158.
3. Nikitina A.S., Popova O.I. Study of triterpene compounds of medicinal hyssop cultivated in the Stavropol Territory. / *Fundamental Research* No. 11 (Part 2) for 2011
4. *State Pharmacopoeia of the Russian Federation XIV edition. Vol. IV.* – Moscow: Ministry of Health of the Russian Federation, 2018. – pp.5960– 5964.

DOI 10.34660/INF.2022.52.88.162

臭氧脱木质素时的生物质破坏。 臭氧化参数的变化
**BIOMASS DESTRUCTION WHEN OZONE DELIGNIFICATION.
 VARIATION OF OZONATION PARAMETERS**

Mamleeva Nadezhda Alekseevna

*Candidate of Chemical Sciences, Associate Professor, Senior researcher
 Lomonosov Moscow State University, Moscow, Russia*

抽象的。 研究了试剂的停留时间和样品中的水分含量 (MC) 对固定床反应器木材臭氧化作用下臭氧的吸收率、比吸收率和转化程度的影响。 结果表明, 在 MC<55-60% 的范围内, 由于扩散限制, 该过程是无效的。 在 MC 60% 时, 由于“非目标”O₃ 与臭氧化产物的反应过程, 该过程无效。 提供了不同臭氧吸收率值下水溶性臭氧化产品的组成数据。 考虑了停留时间对木材臭氧化产品组成的影响。 结果表明, 试剂停留时间和样品中水分含量的变化允许人们调节臭氧对生物质的破坏深度。

关键词: 木材, 木质素, 臭氧化, 水分含量, 试剂停留时间。

Abstract. *The effect of the residence time of the reagent and the moisture content (MC) in the sample on the absorption rate, specific absorption and the degree of transformation of ozone under ozonation of wood in a fixed-bed reactor was studied. It is shown that in the range of MC<55-60% the process is ineffective due to diffusion restrictions. At MC>60%, the process is ineffective due to the course of “non-target” O₃ reactions with ozonation products. Data on the composition of water-soluble ozonation products at different values of specific ozone absorption are presented. The influence of residence time on the composition of wood ozonation products is considered. It is shown that the variation in the residence time of the reagent and the moisture content in the sample allows one to regulate the depth of destruction of biomass by ozonation.*

Keywords: *wood, lignin, ozonation, moisture content, residence time of the reagent.*

Ozone treatment of plant biomass causes the destruction of lignin. The investigations on ozonation of plant substrates showed that the principal physicochemical characteristics of the ozone absorption process are due by the conditions of sample preparation and ozonation parameters. An important condition for delignification under the action of ozone is the presence of water, and the effectiveness of

the ozonation process depends on its content in the sample [1-5]. A lot of research has been devoted to the treatment of lignocellulosic materials (LCM) with ozone, but so far there are no systematic studies on the effect of ozonation parameters on the ozone absorption process, which essentially determine the depth of destruction of the substrate. A comparison of the results of ozonation of plant materials carried out in reactors of various types showed that the process of processing biomass with ozone proceeds most efficiently in a fixed-bed reactor [1,6].

The aim of the present work is to study the effect of the residence time of the reagent and the water content in the sample on the ozone absorption rate, ozone consumption amount, degree of ozone consumption and the depth of the substrate destruction under wood ozonation in a fixed-bed reactor.

Experimental

Samples of aspen and pine wood with a particle size of 0.315 - 0.63 mm and a moisture water content (MC) of 12% ÷ 150% were examined. Ozonation was carried out at $t = 20^{\circ}\text{C}$ in the flow system. Kinetic dependencies of specific absorption and the degree of transformation of ozone at different parameters of ozonation are obtained. Gas flow rate $U=1,6, 2,0$ and $4,5$ l/h. Volume of the sample (V_s) - 0.7 and 2.8 cm³. Ozone concentration 90 mg/l. Residence time (contact time) of the reagent (τ); $\tau=V_s / U$. $\tau = 0.7$ s, 1.3 s and 2.6 s.

The sample volume was calculated by the formula

$$V_s = \frac{m_{o.d.w.}}{\rho_{o.d.w.}} (1 + \beta \times MC_{FSP}) + \frac{m_{o.d.w.}}{\rho_{H_2O}} (MC - MC_{FSP})$$

$m_{o.d.w.}$, m_{bound} , m_{free} —mass of oven dry wood (o.d.w.), «bound» and «free» water, $\beta = \rho_{o.d.w.} / (\rho_{H_2O}^*)$. $\beta = 0,37$, $\rho_{H_2O}^* = 1,26$ g/cm³ (pine). $\beta = 0,44$, $\rho_{H_2O}^* = 1,07$ g/cm³ (aspen) [5].

Fiber saturation point (FSP) $MC=28\%$ (aspen, pine).

Ozone was obtained from oxygen (ozonizer "Medozon-03/8"). Ozone concentration - 90 mg/l ("Medozon - 254/03"). Several series of experiments were carried out, varying the flow rate and the mass of the samples. From the kinetic curves of the dependence of the O₃ concentration at the inlet and outlet of the reactor, the initial rate of ozone absorption, specific absorption (Q_r , mol/g of the sample) and the degree of ozone conversion were determined [4].

The composition of water-soluble ozonation products was analyzed by HPLC on an Agilent 1100 chromatograph with a UV detector (195 nm) and a Rezex ROA column. Movable phase – 0.005 M H₂SO₄, temperature – 65°C; flow rate – 0.5 ml/min.

Results and discussion

Residence time

For a fixed-bed reactor, a model of an ideal displacement reactor is applicable. According to this model, the concentration of the initial substance and reaction products varies along the length of the reactor from the initial value to the final value, and the subsequent volumes of gas or liquid do not mix, completely displacing them.

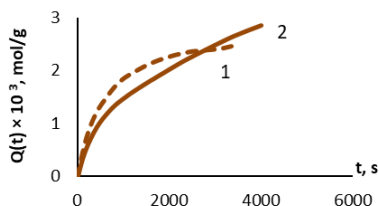


Figure 1. Kinetic curves of ozone specific consumption dependencies during ozonation of pine wood. Residence time, s: 0,7(1), 2,6 (2). MC=60 %.

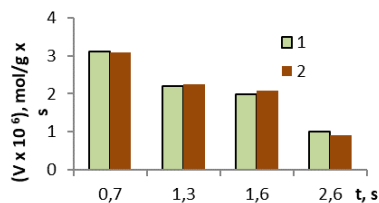


Figure 2. Initial ozone absorption rate of aspen wood samples (1) and pine (2) for different reagent residence times (MC=60%).

The period of time between a gas entering and departure the reaction zone (the inlet and outlet of a reactor) is called the residence time. $\tau = V/U$, where U is the volume of gas entering the reactor per time unit, V is the volume of the reaction zone [7] (in this case equal to the volume of the sample V_s), the residence time $\tau = V_s/U$. Figure 1 shows the kinetic curves of ozone consumption by pine wood for two different values of the residence time. The initial ozone absorption rate, determined by the slope of the absorption curve (Fig.1), decreases with increasing residence time. This is illustrated by Figure 2, which shows that the same pattern is observed for aspen and pine wood.

Moisture content

Figure 3 shows the initial ozone absorption rate of aspen wood with different water content at different residence times. The maximum value of the rate corresponds to the MC of 55%, and with an increase in the residence time the difference in the absorption rates of ozone at different values of the MC is graded. Similar data were obtained for pine wood. In this case, the maximum absorption rate and the degree of ozone conversion correspond to MC 60-65% [4].

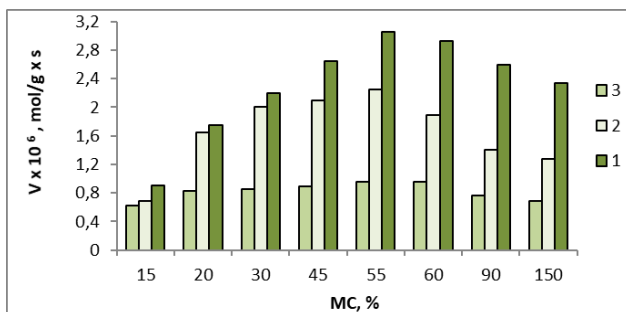
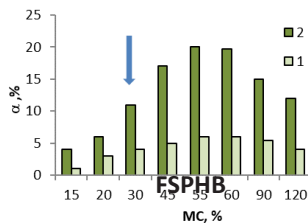
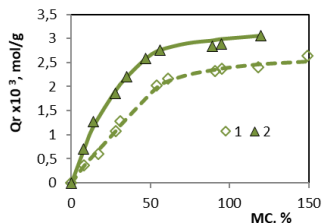


Figure 3. Dependence of the initial ozone absorption rate on the moisture content in the aspen wood at different values of the residence time of the reagent τ , s: 0.7 (1), 1.3 (2), 2.6 (3).

The water content in the sample influences not only the initial absorption rate, but also the specific ozone consumption. Figure 4A shows the specific ozone consumption amount corresponding to the completion of ozonation process depending on the MC. The increase in



A

B

Figure 4. Dependence of specific ozone absorption corresponding to the completion of ozonation (A) and the degree of ozone conversion (B) on the moisture content in aspen wood. τ , s: 0,7 (1), 2,6 (2).

specific ozone consumption occurs in the MC region (55%), and in the region of higher MC values, ozone consumption does not change much. This pattern is observed at different values of the residence time. The degree of ozone conversion (corresponding to the completion of ozonation) reaches a maximum value ($\alpha \sim 20\%$) at MC 55-60%, decreasing with shortening the residence time (Fig. 4B). Figures 3 and 4 show the data obtained for wood samples with different water content relative to the value corresponding to the fiber saturation point (FSP). The MC_{FSP} value corresponds to the amount of water present in the swollen cell wall. It is called “bound water”. In the layer of “bound water”, molecules form hydrogen

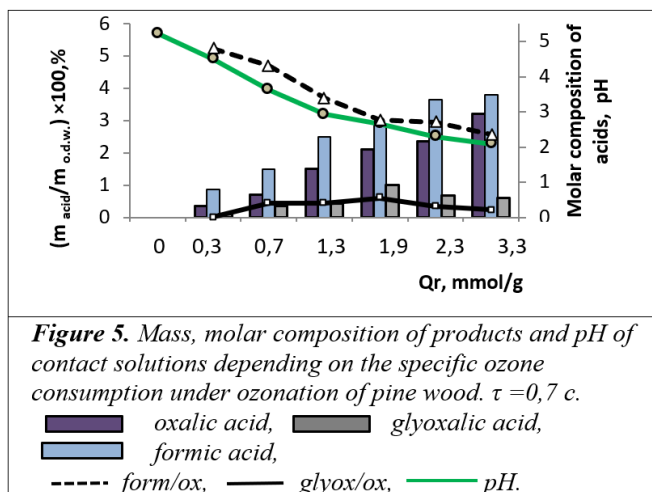
bonds with hydrophilic regions of the wood polymer. The thickness of the bound water layer is 1-1.5 nm [5]. With $MC > MC_{FSP}$, there is also “free water” that fills the cell cavities.

The process of ozone absorption by biomass consists of several stages. From the gas phase, ozone passes into water, then dissolved ozone diffuses to the surface of the substrate, where ozone interacts with functional groups of LCMs. Due to diffusion and thermal movement, a part of the products of the LCM destruction passes into the aqueous phase. In the aqueous phase, the molecules of the reactant interact with the dissolved products of reactions. The water content, at which the totality of the processes occurring in the aqueous phase and on the surface of the LCM, is characterized by the highest rate of ozone absorption, for pine wood corresponds to MC 60-65%, for aspen wood- MC 55-60%. [3,4]

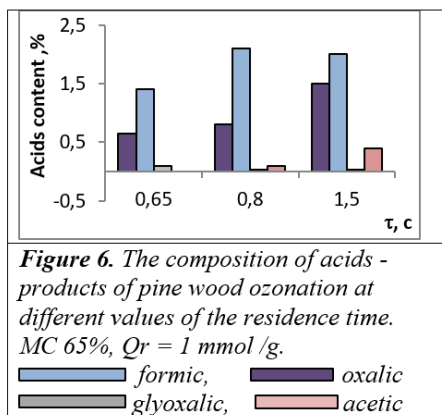
Studies of ozonized aspen and pine wood samples by means of IR spectroscopy, determination of cellulose yield, degree of polymerization of cellulose from ozonized wood, lignin content in ozonized wood samples and analysis of ozonolysis products showed that the noted area of MC corresponds to the deepest destruction of the plant substrate [3,4].

Ozonation products

The main products of the interaction of ozone with wood are formic, glyoxalic and oxalic acids, formed in the ozonolysis reaction of lignin [3]. In Figure 5, the composition of acids at different values of specific ozone absorption is given as a percentage per 1 g of o.d.w.



It can be seen that as the specific ozone consumption increases, the amount of acids increases, and the pH of the contact solution decreases from 5.7 for the initial sample to 2.2 at $Q_r = 3.3$ mmol/g. Data on the acid content in the contact solution are also presented as the dependence of the molar content of formic and glyoxalic acids relatively the molar content of oxalic acid (form/ox, glyox/ox, correspondingly) on the specific ozone consumption. The change in the molar composition of acids is explained by a combination of two processes - the formation of acids as a result of the LG oxidation by ozone and a subsequent oxidation of these products by ozone. Glyoxalic acid is oxidized to oxalic acid, formic and oxalic acids are oxidized into CO_2 and H_2O [9].



The most resistant to ozone action is oxalic acid (the constant of the reaction rate with ozone k (0.01 l/mol×s [8]), so the value of the molar content of the other two acids relative to oxalic acid decreases with an increase in specific absorption of ozone. It can be seen that a decrease in the relative content of formic acid (form/ox) is observed at lower Q_r values compared to the value of glyox/ox for glyoxalic acid. For formic acid, the ozone reaction rate constant $k = 30$ l/mol×s [8], and for glyoxal acid $k = 0.2$ l/mol×s [9]; so the observed pattern is in principle consistent with the values of the reaction rate constants of these compounds with ozone.

Figure 6 shows the composition of acids (as a percentage per 1 g of o.d.w.) in the ozonation of pine wood for different values of residence time. It is seen that in spite of the same value of specific ozone absorption, the composition of the products changes depending on the contact time of the reagent. An increase in τ leads to the oxidation of the most easily oxidized ozone acids (formic and glyoxalic) and the accumulation of more ozone-resistant compounds - oxalic and acetic acids ($k \ll 0.1$ l / mol× c [8]).

In general, an increase in the residence time allows one to achieve higher values of ozone consumption (Fig. 1), but the process of ozone absorption slows down, the selectivity of the process decreases, so with an increase \square more functional groups of the substrate enter into reaction with ozone, including less reactive products of LCM conversion. Thus, Figure 6 shows the presence of acetic acid, which is a product of ozonation of hemicelluloses of wood [2]. Thus, an increase in the value of the residence time leads to the destruction of LCM carbohydrates, which are characterized by high resistance to the action of ozone.

These works show that varying the residence time of the reactant in the reaction zone allows one to control the depth of the biomaterial destruction. With increasing residence time, the ozone conversion degree increases and the ozone absorption rate decreases. The depth of the transformation increases but the selectivity of the substrate transformation process decreases. Variations in the residence time and water content of the substrate can be used to regulate the depth of transformations of wood and other biomass species. For effective treatment of biomass with ozone, when choosing ozonation conditions, the basic physical and physicochemical properties of the plant polymer (density, fiber saturation point, etc.) should be taken into account.

References

1. Travaini, R., Martín-Juárez, J., Lorenzo-Hernando, A., Bolado-Rodriges S.// *Biores.Technol.* V.199. №1. p. 2. 2016.
2. Ben'ko E.M., Manisova O.R., Russ. // *J. Phys. Chem. A.* 2017. V.91. N7. p.1190.
3. Mamleeva N. A., Autlov S. A., Bazarnova N. G., Lunin V.V.// *Russ. J. Bioorg. chem.* 2016. V. 42. N7. p. 694.
4. Mamleeva N.A., Kharlanov A.N., Kupreenko S.Yu, Chukhchin D.G.// *Russ. J. Phys. Chem.A*, 2021. V. 95, no11, p. 2214.
5. Mamleeva N.A., Lunin V.V.// *Russ. J. Phys. Chem. A*, 2016.V. 90, № 11, p. 2150.
6. Garcia-Cubero M. T., L. G. Palacín, Gonzales-Benito G., Bolado S., Lucas S.// *Biores. Technol.* 2012. V. 107. N4. p.229.
7. Planovskaya I.P. / *Methodical development on the topic Kinetics of reactions occurring in the flow.* Izd-vo Khimich. Facultet of Moscow State University -32 p. 1981.
8. Razumovsky S.D., Zaikov G.E. / *Ozone and its reactions with organic compounds. Kinetics and mechanism.* Amsterdam. The Netherlands. Elsevier. 1984.
9. Schöne L. and Herrmann H. // *Atmos. Chem. Phys.* 2014. v.14. p. 4503.

臭氧处理分解木结构

DECOMPOSITION OF WOOD STRUCTURE BY MEANS OF OZONE TREATMENT

Mamleeva Nadezhda Alekseevna

*Candidate of Chemical Sciences, Associate Professor, Senior researcher
Lomonosov Moscow State University, Moscow, Russia*

Kharlanov Andrey Nikolaevich

*Candidate of Chemical Sciences, Senior researcher
Lomonosov Moscow State University, Moscow, Russia*

抽象的。研究了松木对臭氧的吸收。测定了来自臭氧化木材的木质纤维素材料 (LCM) 中木质素 (LG) 和纤维素 (CL) 的含量。已确定来自 LCM 的 CL 的聚合度。LCM样品通过IR光谱法和X射线衍射分析法进行检测。木材的臭氧化会导致 LG 的破坏,其特点是化学计量系数为 $2 \text{ mol O}_3 / \text{mol C}_9\text{PPU LG}$; 达到 40–42% 的脱木素度。脱木素过程伴随着半纤维素和纤维素无定形部分的破坏。已经建立了对应于木质素最有效破坏和纤维素纤维降解最少的臭氧吸收区域。

关键词: 木材, 臭氧化, 脱木素, 红外光谱, X射线衍射分析。

Abstract. *The absorption of ozone by pine wood has been studied. The content of lignin (LG) and cellulose (CL) in lignocellulosic material (LCM) from ozonized wood was determined. The degree of polymerization of CL from LCM has been determined. LCM samples were examined by methods of IR spectroscopy and X-ray diffraction analysis. Ozonation of wood leads to the destruction of LG, which is characterized by a stoichiometric coefficient of $2 \text{ mol O}_3 / \text{mol C}_9\text{PPU LG}$; a degree of delignification of 40–42% is achieved. The delignification process is accompanied by the destruction of hemicelluloses and the amorphous part of the cellulose. An ozone specific absorption region corresponding to the most effective destruction of lignin with the least degradation of cellulose fiber has been established.*

Keywords: *wood, ozonation, delignification, IR spectroscopy, X-ray diffraction analysis.*

To date, the world has accumulated significant experimental material on the interaction of plant biomass with ozone. The prospects for ozone usage for the removal of lignin from plant raw materials has been shown, the economic feasibility

of ozonation for the subsequent production of cellulose, monosaccharides and bioethanol is noted. [1,2]. Among the advantages of ozone as a delignifying agent of biomass, the selectivity of ozone in relation to lignin (LG) is noted, while cellulose (CL) and hemicellulose (HC) are relatively resistant to ozone [2-8].

LCMs from ozonized pine wood were investigated by a number of physicochemical methods (IR spectroscopy, Raman spectroscopy, UV spectroscopy of diffuse reflectance (UV-DO), thermal analysis) [4-11]. It is shown [8] that the process of ozone delignification is accompanied by the destruction of HC and the amorphous part of CL. A decrease in the degree of polymerization of cellulose with an increase in the duration of ozonation was noted. Studies of transformations of wood under the action of ozone have shown the possibility of deep delignification of biomaterial, which, depending on the conditions, may be accompanied by the destruction of HC and CL [2,6]. Wood delignification produces lignin ozonolysis products, which also react with ozone in the cause of the biomass processing [5,8,9].

A necessary condition for effective delignification by ozone treatment is the presence of water in the structure of biomass. It is believed [1-6] that water is a regulator of the swelling process, the medium necessary for the dissolution of ozone, and also plays a transport role in relation to the reagent and the reaction products dissolved in water. The water content regulates the rate of absorption and the degree of transformation of ozone, the maximum achievable value of the amount of absorbed ozone and the depth of destruction of biomass [2-5]. Authors of [11] show that ozone treatment of pine wood with a water content of 60-63% is characterized by a maximum absorption rate and a high degree of ozone conversion.

In the present work, the study of pine wood transformations by ozone treatment continues. The aim of the study is to determine the conditions for the destruction of LG in pine wood, optimal in terms of specific absorption of ozone corresponding to minimal destruction of cellulose. With this, under conditions of optimum water content, kinetic curves of specific ozone absorption were obtained. For LCM from ozonized wood, the LG content have been determined; with the help of IR spectroscopy of diffuse reflectance (DRIFT), the dynamics of LG transformations in wood was studied; LCMs were examined by X-ray diffraction.

Experimental

Pine wood (*Pinus silvestris*) sawdust with a particle size of 0.315–0.63 mm and a moisture content (MC) of $65 \pm 2\%$ relative to the weight of oven dry wood (o.d.w.) served as the object of study. $MC = (m_{H_2O}/m_{o.d.w.}) \times 100\%$. Procedure for sample preparation was described in [11]. We performed a series of experiments with different durations of ozone treatment of wood samples weighing 0.42–0.45 g. Ozonation was carried out in a fixed-bed flow reactor equipped by temperature

controller (25°C). An ozone–oxygen mixture with an ozone concentration of 55 ± 5 mg/L was passed through the reactor at a volumetric flow rate of 4 L/h. The amount of absorbed ozone (Q_r) was calculated from the kinetic curves of the dependence of ozone concentration, according to [5].

The yield of ozonated wood (OW) (Y1) was determined as the ratio of the mass of an oven dry OW sample to the starting o.d.w. weight in percentage. The OW samples were washed with water to remove soluble compounds and dried in air to afford LCM in yield Y2; the yield (Y3) of soluble ozonation products was determined as (Y1–Y2).

The amount of acid-insoluble lignin (AISL) and acid-soluble lignin (ASL) in the initial sample and samples of ozonated wood was determined as described in [12]. The total amount of lignin in the initial sample (LG_0) and in ozonated LCM (LG_{ox}) were determined as the sum of AISL and ASL. The degree of delignification (DD) of wood during ozonation was determined from the relationship: $DD \% = ((LG_0 - LG_{ox})/LG_0) \times 100$.

The number of moles of ozone (A, mol O_3 /mol C_{9PPU}) consumed in the oxidation of the phenyl-propane unit (PPU) of lignin was calculated as $A = Q_r/(LG_0 - LG_{ox})/m_{C_{9PPU}}$, where $m_{C_{9PPU}}$ is the molar weight of guaiacyl-propane unit C_{9PPU} (180 g/mol).

Samples of LCM from the starting and ozonated wood were studied by DRIFT spectroscopy and XRD analysis. DRIFT spectra were recorded on an EQUINOX 55/S infrared Fourier spectrometer (Bruker) with a diffuse reflectance attachment. A powder fraction of KBr dried at 400°C was used as a reference. The resulting reflection spectra were converted to Kubelka–Munk units.

The X-ray diffraction patterns of pine wood The X-ray diffraction patterns of pine wood were recorded on a Shimadzu XRD 6000 diffractometer using Cu $K\alpha$ radiation ($\lambda = 0.15418$ nm) in the angle range of 5–45° (on a 2θ scale) with a step of 0.03°. The crystallinity index (CrI) was calculated by the formula: $CrI = (1 - I_{002}/I_a) \times 100\%$ proposed in [13], where I_{002} and I_a are the peak intensities at $2\theta = 22.5^\circ$ and $\approx 19.0^\circ$. To determine the average size D of nanocrystallites (coherent scattering region (CSR)), the diffraction maximum (002) was analyzed using the Lorentz function for approximation. The average CSR size was estimated using the Selyakov–Scherer formula: $D = \lambda/\beta \cos \theta$, where λ is the X-ray wavelength (nm), β is the half-width of maximum 002 (rad), and θ is the Wolfe–Bragg angle. The error in the estimation of the CSR value was 5–7%.

Results and discussion

Figure 1 shows the dependence of the amount of lignin in the LCM obtained from ozonated wood on the specific absorption of ozone. It can be seen that in the range of 0–1.5 mmol/g, the dependence is linear, the lignin content decreases from 28.0 to 17.8%, and the delignification degree in this region reaches 36%. At higher

Qr values, the lignin content and DD vary insignificantly. At Qr 3.0 mmol/g, the lignin content is 16.2%, and DD reaches 42%.

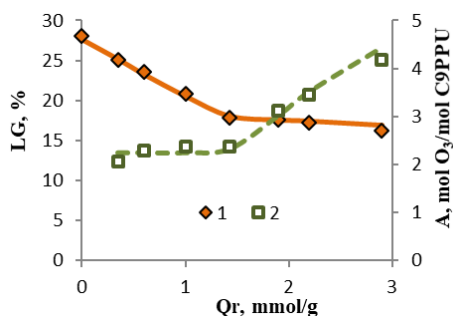


Figure 1. Lignin content in LCM, obtained from ozonated wood (1) and amount of ozone (A), reacted with C9PPU of lignin (2), depending on specific ozone consumption.

Curve 2 (Fig. 1), was obtained under the assumption that ozone reacts only with lignin; it shows that at $Qr \leq 1.5$ mmol/g, the number of moles of ozone (A) for C9PPU oxidation is 2.2 ± 0.2 mol O₃/mol C9PPU. An increase in parameter A at higher Qr indicates that ozone also reacts with other components of the sample. Table 1 shows the yields of ozonated wood (Y1), cellulose-containing LCM (Y2) and soluble ozonation products (Y3), the amount of oxidized lignin (LGox,%), crystallinity index (CrI), and CSR size (D, nm) for various values of specific ozone absorption (Qr, mmol/g); the cellulose content in LCM (%), the cellulose polymerization degree (PD) were found in [8].

Table 1 show that with an increase in Qr, the yield of water-soluble products (Y3) increases, the cellulose content increases from 50% (LCM from the original pine wood) to 58–59% for LCM from ozonated wood, its degree of polymerization gradually decreases, and other structural characteristics are changed. A comparison of the oxidized lignin content (LGox) and the yield of water-soluble products (Y3) shows that their values increase symbatically, but the amount of products is almost twice as high as Lgox. This indicates that the impact of ozone on wood is not limited to lignin destruction.

Table 1.

Yields of ozonated wood (Y1, %), LCM (Y2, %), soluble products of ozonation (Y3, %), and cellulose (Y4, %); the amount of oxidized lignin (Lg_{ox}, %); the cellulose (CL, %) content in LCM; the cellulose polymerization degree (PD); crystallinity index (CrI); and CSR size (D, nm) for various values of specific ozone absorption (Qr, mmol/g).

Qr, mmol/g	Y1%	Y2,%	Y3,%	Y4,% [8]	Lg _{ox} , %	CL,% [8]	PD [8]	CrI	D, nm
0	100	98±1	2±0,5	49±1	0	50±1	760±20	0,73	3,4
0,7±0,07	100±1	90±1	10±1	48±1	4,5	53±1	720±20	-	-
1,0±0,10	101±1	88±1	13±2	48±1	7,2	54±1	700±20	0,75	3,5
1,5±0,15	102±1	84±1	18±2	48±1	10,2	57±1	620±20	0,78	3,5
2,0±0,20	101±1	82±1	19±2	47±1	10,4	58±1	520±20	0,79	3,6
3,0±0,30	101±1	80±1	21±2	47±1	11,8	59±1	480±20	0,80	3,6

According to the Ph. Bailey's ozonation scheme [12], a total of 3 moles of acids are formed from 1 mole of phenol in reaction with ozone. In the work [8] was shown that with a specific absorption of ozone of 1.5 mmol / g in terms of 1 g of o.d.w., a total amount of 1.3 mmol of oxalic, formic and glycoxalic acids was formed. In accordance with the scheme, this amount of acids is formed during the oxidation of about 0.4 mmol of the phenolic compound with ozone. As follows from Table 1, at Qr of 1.5 mmol/g, 10.2% lignin (0.6 mmol C9PPU) was destroyed. A comparison of the values of oxidized LG and the yield of water-soluble products (Y3) shows that their values increase symbatically, but the amount of products is almost twice as high as the amount of oxidized lignin (Lg_{ox}). This result shows that when wood is ozonized, ozone reactions are not limited to the destruction of LG.

The results of the composition of acids determination undoubtedly indicate that ozonolysis takes place with the participation of lignin located directly in the LCM structure. However, when comparing the amount of acids with the amount of oxidized lignin, it should be taken into account that the acid content is underestimated due to the ozone oxidation shown in a lot of papers [6,8,10,11].

The DRIFT spectra of the starting wood and ozonated samples are shown in Fig. 2. The spectra are presented in Kubelka–Munk units ($F(R)$), which are the equivalent of optical density in the reflectance spectroscopy. The spectra are normalized to the band at 1128 cm⁻¹. The main changes in the $F(R)$ values in the spectra of ozonated samples are observed in the region of vibrations of aromatic structures and carboxyl groups. The bands at 1511 and 1598 cm⁻¹ related to skeletal vibrations of aromatics [13,14] in the spectra of ozonated samples are decreased. The band at 1662 cm⁻¹ is assigned to the vibrations of C=O conjugated to

the aromatic ring. Some authors believe that C=C vibrations also contribute to this band [13, 14]. The band intensity is markedly decreased with increasing Qr. The band at 1267 cm⁻¹ (skeletal vibrations of the G ring + C_{Ar}-C-O vibrations [19]) is also decreased.

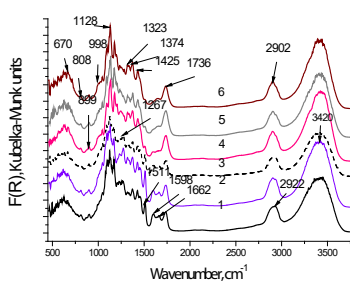


Figure 2. DRIFT spectra of LCM samples.
Qr, mmol/g: 0 (1), 0,7 (2), 1,0 (3), 1,5 (4), 2,0 (5), 3,0 (6).

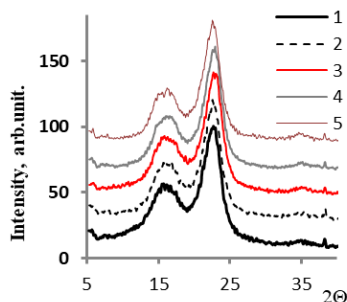


Figure 3. Diffraction patterns of LCM samples; Qr, mmol/g: 0 (1), 1,0 (2), 1,5 (3), 2,0 (4), 3,0 (5).

According to DRIFT spectra (Fig. 2), aromatic degradation is observed at the whole Qr range, but it prevails at Qr ≤ 1,5 mmol/g (spectra 2–4); the intensity of the bands at 1736 cm⁻¹ of unconjugated C=O groups of lignin and HCs noticeably increases in the Qr range of 1.0–2.0 mmol/g [13]. In the Qr interval of 1.5–3.0 mmol/g, the spectrum contour is changed in the region of stretching C–H vibrations (2850–3000 cm⁻¹) (spectra 4–6); the band at 808 cm⁻¹ attributed to glucomannan is decreased [13]. These data indicate that hemicelluloses are also involved in the process of substrate destruction at high Qr values.

The band at 3420 cm⁻¹ corresponds to stretching vibrations of OH groups bound by a hydrogen bond [13, 14]. With an increase in Qr, the band position is preserved, the band half-width is decreased from 360 cm⁻¹ (spectrum 1 in Fig. 2) to 300 cm⁻¹ (spectrum 6), which indicates the destruction of the network of hydrogen bonds of wood and the formation of a new structure with hydrogen bonds that are more homogeneous in term of energy.

The diffraction pattern of the starting wood is characterized by peaks at 20.147°, 16.6°, and 22.5° related to atomic reflections in the (101), (10 $\bar{1}$) and (002) planes. Interplanar spaces of 6.01, 5.34, and 3.95 Å are close to the corresponding crystal lattice parameters of the wood cellulose I [15]. The features of the diffraction patterns of wood are due to the alternation of amorphous and crystalline regions in cellulose included in the structure of the lignin-carbohydrate complex (LCC). A model of a two phase amorphous-crystalline structure is often used to

describe the structure of natural cellulose. The relative content of crystalline cellulose in the material is characterized by a “crystallinity index” (CrI), the value of which allows estimation the fraction of regularly packed molecules [16, 17]. A comparison of the CrI values allows a semiquantitative assessment of the fraction of crystalline and amorphous phases in the test sample. The CrI estimation using “peak” ($10\bar{i}$) intensities at angles attributed to crystalline and amorphous phases is the most common [16]. The CrI values and CSR size (D, nm) for various values of specific ozone absorption are given in Table 1. The average crystallite size (3.4–3.6 nm) is close to the CSR values obtained in [18].

As Qr increases, the CrI value increases. An increase in D and CrI indicates the destruction of the amorphous phase; moreover, a change in these characteristics is symbatic to the yield of soluble products of ozonation (Y3). A correlation between CrI, the amount of removed lignin, and the yield of soluble ozonation products was observed during the treatment of deciduous and coniferous wood with ozone [8, 11]. The destruction of the amorphous phase is accompanied by a decrease in PD of cellulose and is explained by the destruction of amorphous cellulose when ozonation of wood.

From the data of Table 1 it follows that with an increase in Qr up to 1.5 mmol/g, the main destruction of the amorphous phase occurs, moreover, due to the destruction of lignin and HCs. A change in the cellulose polymerization degree (PD) in this Qr interval is small, therefore the destruction of cellulose at this stage is insignificant. An increase in the D and CrI values also occurs at Qr more than 1.5 mmol/g, where the lignin content varies little, but the cellulose PD is changed noticeably. The amount of dissolved products of wood ozonation is increased in this range of ozone consumption; this indicates the destruction of wood carbohydrates (HC and amorphous CL). In the range of 2.0–3.0 mmol/g, ozone is consumed mainly in reactions with the products of oxidative degradation of wood.

From the point of the main task of wood delignification, the ozone consumption range $Qr \leq 1.5$ mmol O₃/g seems to be the most acceptable; at the delignification degree of 36%, the ozone conversion rate is 55% (ozone dose of 2.7 mmol O₃/g or 140 mg O₃/g) [11].

The process of ozone absorption by biomass consists of several stages. Ozone goes into water from the gas phase; then dissolved ozone diffuses to the surface of the substrate, where ozone interacts with the functional groups of LCM. Due to diffusion and thermal motion, part of the LCM degradation products goes into the aqueous phase. In the aqueous phase, the reactant interact with the reaction products dissolved in water. The water content at which the set of processes occurring in the aqueous phase and on the LCM surface is characterized by the highest ozone absorption rate; for pine wood it corresponds to 60–63% [11]. The interaction of ozone with wood takes place in amorphous regions of LCC. Aromatics available

to the reagent are destroyed first; this process inevitably leads to the conversion of polysaccharides covalently linked to lignin. As a result, delignification is accompanied by destruction of HCs and the accessible (amorphous) part of cellulose.

Ozonolysis is considered as the main mechanism of destruction of lignin in biomass by ozone treatment [6]. The ozonolysis scheme suggests that 3 moles of ozone react with 1 mole of phenol [12]. The calculation showed that when ozonizing pine wood, 2.2 ± 0.2 moles of O_3 are required for the destruction of one mole of the C9PPU at Qr of 1.5 mmol / g (Fig.1). At higher Qr, reactions occur with oxidation products in solution, and polysaccharides are oxidized, the A parameter increases to 3 or more (Fig. 1.). We suppose that a part of lignin in the wood was destroyed not by ozonolysis, but as a result of other mechanisms. For example, the formation of phenoxyl radicals followed by opening the aromatic ring [19] can be one of the significant pathways for LG transformations when ozonation. In this case the formation of unsaturated acids, aldehydes, and peroxide compounds also takes place.

In addition, processes involving $OH\cdot$ (radicals) are possible, which are generated as a result of ozone interaction with water [20], and also occur in the course of further transformations of H_2O_2 (a product of O_3 reactions with aromatics) [12,19]. Their role increases at a pH above 3, and at the initial stages of ozonation, the contribution of these processes can be significant. Ozonation leads to acids formation, and the pH of contact solutions decreases from 5.6 to 2.5 [6,8], therefore, reactions involving $OH\cdot$ more likely at the initial stage of ozonation, and the role of the mechanism proposed by Ph. Bailey increases at low pHs produced as a result of biomass ozonation.

Thus, the treatment of pine wood with ozone leads to the destruction of LG, which is characterized by a stoichiometry of ~ 2 mol O_3 /molC9PPU LG. The degree of delignification achieved in ozonation is 40-42%. The main mechanism of destruction of aromatics in wood is the ozonolysis reaction. The process of ozonolytic delignification is accompanied by the destruction of hemicelluloses biomass, and at high ozone costs the amorphous part of the cellulose also deconstructs. The experimental data shows that the ozone specific absorption region (≤ 1.5 mmol O_3 /g) corresponds to the most efficient process of delignification of pine wood, in which the change in the degree of polymerization of cellulose is minimal.

References

1. Perrone O. M, Colombari F., Rossi J., et al. // *Biores. Technol.* 2016. V.218. P.69.
2. García-Cubero M.T., Palacín L.G., González-Benito G., Bolado S., Lucas S., Coca M. // *Biores. Technol.* 2012. V.107. P. 229

3. Li C., Wang L., Chen Z., Li Y., et al. // *Biores. Technol.* 2015. V.183. P.240.
4. Benko E.V., Chukhchin D.G., Lunin V.V.// *Holzforschung*, 2020.v.74. No12.p.1157
5. Mamleeva N.A., Kharlanov A.N., Kupreenko S.Yu, Chukhchin D.G.// *Russ. J. Phys. Chem.A*, 2021. V. 95, no11, p. 2214.
6. Mamleeva N.A., Ben'ko E.M., Kharlanov A.N., Shumyantsev A.V., Chukhchin D.G. // *Russ. J. Phys. Chem. A*, 2021 V. 95, No 3, p. 577.
7. Mamleeva N.A., Kharlanov A.N., Lunin V.V.// *Russ. J. Phys. Chem. A*, 2019.V. 93, N12. P.1901
8. Mamleeva N.A., Kharlanov A.N., Chukhchin D.G., Bazarnova N. G, and Lunin V. V. //*Russ. J. Bioorg.Chem.* 2020, Vol. 46, No. 7, p. 1330.
9. Ben'ko, E.M., Manisova, O.R., and Lunin, V.V. //*Russ. J. Phys. Chem. A*, 2017, vol. 91, no. 7, p. 1190.
10. Andersen, S.L.F., Castoldi, R., Bracht, A., Peralta, R.A., et.al. //*Wood Sci. Technol.*, 2019, vol. 53, Issue 1, p. 49.
11. Mamleeva, N.A., Babayeva, N.A., Kharlanov, A.N.,and Lunin, V.V. //*Russ. J. Phys. Chem. A*, 2019, vol. 93, no. 1, pp. 37.
12. Bailey, P.S./ *Ozonation in Organic Chemistry*. Vol. 2. Nonolefinic compounds. Acad. Press, New York. 1982. p. 31.
13. Schwanninger M., Rodrigues J.C., Pereira H., Hinterstoesser B. *Vibrational Spectroscopy*. 2004. V.36 p. 23–40.
14. Proniewicz L. M., Paluszkievicz C., Weselucha-Birczyn'ska A., Baran'ski A., Dutka D.,// *J. Mol. Structure*. 2002. V.614. p.345.
15. Aleshina L.A., Glazkova S.V., Lugovskaya L.A., Podoinikova M.V., Fofanov A.D., Silina E.V.// *Khimiya Rastitel'nogo Syr'ya*, 2001. №1. S. 5-36.
16. Segal L., Creely J.J., Martin Jr. A.E., Conrad C.M.. *Tex. Res. J.* 1959.V.29. N10. Pp. 786-794.
17. Park S., Baker J.O., Himmel M.E, Parilla P.A., Johnson D.K.. *Biotechnol. Biofuels*. 2010. V.3.N 10.
18. Mamleeva, N.A., Abrosimova, G.E., Kharlanov, A.N., and Lunin, V.V.// *Russ.J. Phys. Chem. A*, 2013, vol. 87, no. 7, pp. 1102–1107.
19. Razumovsky S.D., Zaikov G.E. /*Ozone and its reactions with organic compounds. Kinetics and mechanism*. Amsterdam. The Netherlands. Elsevier. 1984.
20. Staehelin, J. and Hoigne, J.// *Environ. Sci. Technol.*, 1982, vol. 16, no. 12, pp. 666–681

构建用于控制具有延迟切换的设备的稳健系统
**CONSTRUCTION OF ROBUST SYSTEMS FOR CONTROLLING OF
PLANTS WITH SWITCHING WITH DELAY**

Ternovaja Galina Nikolaevna

*Doctor of Technical Sciences, Full Professor
Astrakhan State Technical University*

Parsheva Elizaveta Alexandrovna

*Candidate of Technical Sciences, Associate Professor
Astrakhan State Technical University*

摘要：研究了存在时延的线性系统的鲁棒控制问题。这项工作的目的是创建一个控制系统，为参考信号提供给定的跟踪误差，该参考信号具有来自可能值类别的任意参数。只有系统的标量输入和输出可用于测量。未测量的有界扰动作用于每个子系统。所提出的算法保证以所需的精度跟踪参考信号。结果用一个例子来说明：跟踪一个由三个子系统组成的系统的参考信号

关键词：开关系统，鲁棒控制，李雅普诺夫函数，参考信号

Abstract. *The problem of robust control for a linear system with switching in the presence of delay is studied. The aim of the work is to create a control system that provides a given tracking error for the reference signal with arbitrary parameters from the class of possible values. Only the scalar input and output of the system are available for measurement. Unmeasured bounded perturbations act on each of the subsystems. The proposed algorithm guarantees tracking of the reference signal with the required accuracy. The results are illustrated with an example: tracking a reference signal for a system consisting of three subsystems*

Keywords: *switching system, robust control, Lyapunov function, reference signal*

1. Introduction

Differential equations with switched parameters are used in traffic control systems, energy and chemical industries [1], in economic models [2, 3]. Therefore, in many published works [4-11], various aspects of the operation of such systems are studied and control systems are synthesized for them. In [4], a control system is synthesized using the switched Lyapunov function. The general approach to the analysis of switched systems with an arbitrary method of switching parameters is

described in [5]. The problem of stabilization using the Lyapunov inequality is studied in [6]. In [7], the problem of stabilization is solved for a nonlinear system with a delay of neutral type, when the state vector and the switching signal are available for measurement. With the help of the Lyapunov-Krasovskii functional, which is formed for each subsystem, the feedback matrices for each of the subsystems are obtained. The final result is formulated in terms of matrix inequalities. In [8], a linear system with a delay in state is considered, the control parameter is the switching signal, the formation algorithm of which is obtained. The principle of extended invariance is used in [9]. The geometric approach was applied in [10], the H_∞ theory in [11]. In [12], a criterion for the existence of a general quadratic Lyapunov function for a set of second-order linear systems was developed. Hybrid mechanical systems with switching force fields, whose mathematical models are second-order differential equations, were studied in [13-15].

In this paper, switching parameters are considered as parametric disturbances, which made it possible, using the results obtained in [16, 17], to obtain a robust control algorithm that allows, without switching the parameters of the control device, to qualitatively control an object with switched parameters in the presence of uncontrolled limited external disturbances.

2. Formulation of the problem

Consider the control object, the mathematical model of which is the following equations:

$$\begin{aligned}\dot{x}(t) &= A(q(t))x(t) + D_1(q(t))x(t - \tau) + B(q(t))u(t) + \Gamma(q(t))f(t), \\ y(t) &= Lx(t),\end{aligned}\quad (1)$$

where $x \in R^n$ – state vector, $y \in R$, $u \in R$ – adjustable and control variables, $f \in R$ – external disturbance, $A(q(t))$, $B(q(t))$, $\Gamma(q(t))$, $D_1(q(t))$ – set of constant numerical matrices, $q(t) : [t_0, \infty) \rightarrow I = \{1, \dots, r\}$ – switching signal. Depending on its value, matrices are switched in equation (1). In other words, there are r sets of matrices $A(q(t))$, $B(q(t))$, $\Gamma(q(t))$, $D_1(q(t))$, which are switched during the operation of the system by the signal $q(t)$.

It is required to obtain a control algorithm that ensures the fulfillment of the target condition

$$|y(t) - y_m(t)| < \delta, \text{ when } t > t_0 \quad (2)$$

for any given set of matrices for an arbitrary switching signal. In this case $y_m(t)$ – reference limited signal, which must be tracked with a given accuracy δ for some finite time t_0 .

We will solve the problem of tracking the reference signal for an object with switched parameters under the following assumptions.

Assumptions. Object (1) is stabilizing for any values $q(t)$.

1. The values of the matrices are unknown, but the ranges of possible values of the parameters of the matrices are known.
2. The maximum possible relative degree is known $\gamma = \max \gamma_i$, $\gamma_i = n - m_i$ for transfer functions of subsystems $W(\lambda) = R_{m_i}(\lambda) / Q_n(\lambda) = L(\lambda I_n - A_i)^{-1} B_i$ where λ – complex variable in the Laplace transform, n, m_i – polynomial orders, I_n – identity matrix of order $n \times n$.
3. The disturbing action $f(t)$ and the reference signal $y_m(t)$ are smooth bounded functions.
4. The controlled variable is available for measurement, but its derivatives are not measured.
5. Switching signal $q(t)$ is not measured.

3. Solution method

Let us transform equation (1) into the input-output form and write it in operator form

$$Q_n(P, q(t)) y(t) + D(P, q(t)) y(t - \tau) = R_{m_i}(P, q(t)) u(t) + G_g(P, q(t)) f(t) \quad (3)$$

where $P = d/dt$ – differentiation operator,

$Q_n(P, q(t))$, $R_{m_i}(P, q(t))$, $D(P, q(t))$, $G_g(P, q(t))$ – linear differential operators whose parameters are switched by a signal $q(t)$. The indexes of the operators here and below will indicate their order. The operator $Q_n(P, q(t))$ is normalized.

We use the following obvious polynomial equality

$$Q_\gamma(P) M_{n-1}(P, i) = Q_n(P, i) S_{\gamma_i-1}(P, i) + N_{n+\gamma-2}(P, i). \quad (4)$$

Here all polynomials are normalized, and polynomials $Q_\gamma(P, i)$, $M_{n-1}(P, i)$, $S_{\gamma_i-1}(P, i)$ are Hurwitz and normalized. Obviously, there always exists a polynomial $N_{n+\gamma-2}(P, i)$, that ensures equality (4).

We multiply equation (4) by $y(t)$, and in the first term on the right side we substitute $y(t)$, determined from equation (3)

$$\begin{aligned} Q_\gamma(P) M_{n-1}(P, i) y(t) &= \\ &= S_{\gamma_i-1}(P, i) (R_{m_i}(P, i) u(t) + D(P, i) y(t - \tau) + G_g(P, i) f(t)) + N_{n+\gamma-2}(P, i) y(t) \end{aligned}$$

Let's perform «operator division»

$$\frac{S_{\gamma_i-1}(P, i) R_{m_i}(P, i)}{M_{n-1}(P, i)} = r_0(i) + \frac{D_{n-2}(P, i)}{M_{n-1}(P, i)}, \quad \frac{N_{n+\gamma-2}(P, i)}{M_{n-1}(P, i)} = G_{\gamma-1}(P, i) + \frac{K_{n-2}(P, i)}{M_{n-1}(P, i)}$$

Here $r_0(i)$ – is the coefficient of the highest degree of the operator $R_{m_i}(P, i)$. As a result of the performed transformations, we obtain

$$Q_\gamma(P)y(t) = r_0(i)u(t) + \chi_1(t, i), \quad (5)$$

$$\begin{aligned} \chi_1(t, q(t)) &= G_{\gamma-1}(P, i)y(t) + \frac{D_{n-2}(P, i)}{M_{n-1}(P, i)}u(t) + \frac{K_{n-2}(P, i)}{M_{n-1}(P, i)}y(t) + \\ &+ \frac{S_{\gamma-1}(P, i)D(P, i)}{M_{n-1}(P, i)}y(t - \tau) + \frac{S_{\gamma-1}(P, i)G_g(P, i)}{M_{n-1}(P, i)}f(t) \end{aligned}$$

We introduce a new control action in accordance with the formula

$$u(t) = \alpha v(t)$$

and write an equation for the tracking error $e(t) = y(t) - y_m(t)$

$$Q_\gamma(P)e(t) = v(t) + \chi(t, i). \quad (6)$$

Here $\chi(t, i) = (r_0(i) \alpha - 1)v(t) + \chi_1(t, i) + Q_\gamma(P)y_m(t)$, $\alpha > 0$.

We write equations (6) in vector-matrix form for the i -th set of matrices

$$\dot{\varepsilon}(t) = A_m \varepsilon(t) + b v(t) + b \chi(t, i) \quad e(t) = L_1 \varepsilon(t) \quad i = 1, \dots, r, \quad (7)$$

$$\chi(t, i) = (r_0(i) \alpha - 1)v(t) + \chi_1(t, i) + Q_\gamma(P)y_m(t)$$

$$\chi_1(t, i) = -c_i Y(t) - \tau_i \sigma_i(t) + g_i \varphi_i(t) + \psi(t, i),$$

$$\dot{\sigma}_i(t) = D_i \sigma_i(t) + b y(t), \quad \dot{\varphi}_i(t) = D_i \varphi_i(t) + b u(t),$$

where $L_1 = [1, 0, \dots, 0]$, $b^T = [0, \dots, 0, 1]$,

$$\sigma_i \in R^{n-1}, \varphi_i \in R^{n-1}, Y \in R^\gamma, \varepsilon \in R^\gamma, \psi(t, i) = \frac{S_{\gamma-1}(P, i)G_g(P, i)}{M_{n-1}(P, i)}f(t)$$

$Y^T(t) = [y(t), y'(t), \dots, y^{(\gamma-1)}(t)]$, c_i , τ_i , g_i – row matrices whose elements are the coefficients of the i -th operators $G_{\gamma-1}(P, i)$, $K_{n-2}(P, i)$, $D_{n-2}(P, i)$ respectively, written in reverse order, A_m , D_i – are Hurwitz matrices in the Frobenius form, whose elements are the coefficients of the operators $Q_\gamma(P)$ and $M(P, i)$. Let us introduce the matrices

$$C = \begin{bmatrix} c_1 \\ \vdots \\ c_r \end{bmatrix}, T = \begin{bmatrix} \tau_1 \\ \vdots \\ \tau_r \end{bmatrix}, G = \begin{bmatrix} g_1 \\ \vdots \\ g_r \end{bmatrix}, r_0 = \begin{bmatrix} r_{01} \\ \vdots \\ r_{0r} \end{bmatrix}, \sigma = \begin{bmatrix} \sigma_1 \\ \vdots \\ \sigma_r \end{bmatrix}, \varphi = \begin{bmatrix} \varphi_1 \\ \vdots \\ \varphi_r \end{bmatrix}, \psi(t) = \begin{bmatrix} \psi(t, 1) \\ \vdots \\ \psi(t, r) \end{bmatrix},$$

$$\omega = [\omega_1, \dots, \omega_r], \quad \omega_i = \begin{cases} 1, & \text{если } i = q(t), \\ 0, & \text{если } i \neq q(t). \end{cases} \quad \text{and block diagonal matrices}$$

$D = \text{diag}\{D_1, \dots, D_r\}$ $B = \text{diag}\{b, \dots, b\}$, Then equations (7) can be written as

$$\begin{aligned} \dot{\varepsilon}(t) &= A_m \varepsilon(t) + b v(t) + b \chi(t), \quad e(t) = L_1 \varepsilon(t), \\ \chi(t) &= \omega((r_0 \alpha - 1) v(t) + CY(t) - T\sigma(t) + G\varphi(t) + \psi(t)) + Q_\gamma(P) y_m(t), \quad (9) \\ \dot{\sigma}(t) &= D\sigma(t) + By(t), \quad \dot{\varphi}(t) = D\varphi(t) + Bu(t). \end{aligned}$$

We have obtained a system of equations in which all perturbations and uncertainty are concentrated in the function $\chi(t)$. In this case, the switching of parameters is considered as stepwise parametric perturbations. The task of constructing a control algorithm is to suppress these perturbations.

Let us use the results of [16] and introduce an auxiliary contour, the mathematical model of which is the equation

$$\dot{\varepsilon}_b(t) = A_m \varepsilon_b(t) + b v(t) \quad e_b(t) = L_1 \varepsilon_b(t). \quad (10)$$

Let's make an equation for the mismatch vector $z(t) = \varepsilon(t) - \varepsilon_b(t)$, subtracting (10) from (9)

$$\dot{z}(t) = A_m z(t) + b \chi(t) \quad \zeta(t) = e(t) - e_b(t) = L_1 z(t). \quad (11)$$

From equation (11), taking into account the structure of the matrix A_m , it follows that the generalized perturbation $\chi(t)$, can be calculated in accordance with the formula $\chi(t) = Q_\gamma(P) \zeta(t)$. Then the ideal control law is determined using the formula

$$u(t) = -Q_\gamma(P) \zeta(t).$$

In this case, the tracking error equation (9) will be asymptotically stable.

Taking into account that the derivatives of the input and output variables are not measured, we will form the control signal $v(t)$ in the form

$$v(t) = -q_m^T \xi(t), \quad (12)$$

where $\xi^T(t) = [\bar{\zeta}(t) \ P \bar{\zeta}(t) \ \dots, P^\gamma \bar{\zeta}(t)]$, $\bar{\zeta}(t)$ – vector of signal derivative estimates $\zeta(t)$, q_m – a vector whose components are the coefficients of the operator $Q_\gamma(P)$, written in reverse order. Vector $\bar{\zeta}(t)$ obtained with an observer [18]

$$\dot{\bar{\theta}}(t) = \Gamma_0 \bar{\theta}(t) + d_0 (\zeta(t) - \bar{\zeta}(t)), \quad \bar{\zeta}(t) = L_1 \bar{\theta}(t). \quad (13)$$

Here $\xi(t) \in R^\gamma$, $\Gamma_0 = \begin{bmatrix} 0 & I_{\gamma-1} \\ 0 & 0 \end{bmatrix}$, $d_0 = \begin{bmatrix} \frac{d_1}{\mu}, \dots, \frac{d_\gamma}{\mu^\gamma} \end{bmatrix}$, the numbers d_1, \dots, d_γ

are chosen so that the matrix $\Gamma = \Gamma_0 + \bar{d} L_1$ was Hurwitz, $\bar{d} = [d_1, \dots, d_\gamma]$, $\mu > 0$ – a fairly small value. We introduce two vectors $\bar{\sigma}^T(t) = [\zeta(t), P\zeta(t), \dots, P^{\gamma-1}\zeta(t)]$, $\eta(t) = \Gamma^{-1}(\bar{\theta}(t) - \bar{\sigma}(t))$, $\Gamma = \text{diag}\{\mu^{\gamma-1}, \dots, \mu, 1\}$. Then, taking into account the equality $\dot{\bar{\sigma}}(t) = \Gamma_0 \bar{\sigma}(t) + b \zeta^\gamma(t)$, from equation (13) we obtain the equation for normalized deviations $\eta(t)$

$$\dot{\eta}(t) = \frac{1}{\mu} \Gamma \eta(t) - b \zeta^\gamma(t) \quad \Delta(t) = \bar{\zeta}(t) - \zeta(t) = \mu^{\gamma-1} \eta_1(t) = \mu^{\gamma-1} L_1 \eta(t) \quad (14)$$

We substitute the value of $\mathfrak{U}(t)$ from (12) into (9), as a result of which we obtain the equation of a closed system

$$\begin{aligned} \dot{\varepsilon}(t) &= A_m \varepsilon(t) + \mu^{\gamma-1} b q_m^T \bar{\Delta}(t), \quad e(t) = L_1 \varepsilon(t), \\ \dot{\varepsilon}_b(t) &= A_m \varepsilon_b(t) - b q_m^T \xi(t), \quad e_b(t) = L_1 \varepsilon_b(t), \quad \zeta(t) = \varepsilon(t) - \varepsilon_b(t), \quad (15) \\ \dot{\eta}(t) &= \frac{1}{\mu} \Gamma \eta(t) - b \zeta^\gamma(t), \quad \Delta(t) = \bar{\zeta}(t) - \zeta(t) = \mu^{\gamma-1} \eta_1(t) = \mu^{\gamma-1} L_1 \eta(t), \end{aligned}$$

where $\bar{\Delta}^T(t) = [\eta_1(t), \eta_1'(t), \dots, \eta_1^\gamma(t)]$. We have obtained a singularly perturbed system of equations, since μ is a small quantity.

Statement. *Let the conditions of the assumptions be satisfied. Then there is a number μ_0 such that when the inequality $\mu < \mu_0$, is satisfied, the control algorithm (10), (12), (14) ensures the fulfillment of the target condition (2) for the control object (1) with an arbitrary way of switching parameters.*

Thus, as a result of the fact that the mathematical model of the tracking error is transformed into the form (7), where the switchings are considered as parametric perturbations, it is possible to obtain a control algorithm without switchings. In addition, it should be noted that when analyzing the performance, it is sufficient to use one Lyapunov function.

Proof. Since the system of equations (15) is singularly perturbed, the analysis of its functioning consists of two stages. First, we study the reduced system, and then we determine the area of attraction of the system.

Let us use the lemma for the system of equations

$$\begin{aligned} \dot{\varepsilon}(t) &= A_m \varepsilon(t) + \mu_2^{\gamma-1} b q_m^T \bar{\Delta}(t), \quad e(t) = L_1 \varepsilon(t), \\ \mu_1 \dot{\eta}(t) &= \Gamma \eta(t) - \mu_2 b \zeta^\gamma(t), \quad \Delta(t) = \bar{\zeta}(t) - \zeta(t) = \mu_1^{\gamma-1} \eta_1(t) = \mu_1^{\gamma-1} L_1 \eta(t), \end{aligned} \quad (D.1)$$

where $\mu_1 = \mu_2 = \mu$

Lemma[19] *If the dynamic system is described by the equation*

$$\dot{x}(t) = f(x, \mu_1, \mu_2) \quad x(t) \in R^n, \quad \mu_1 > 0, \mu_2 > 0, \quad (D.2)$$

where $x \in R^n$, $f(x, \mu_1, \mu_2)$ – continuous function, Lipschitz in x . and for $\mu_2 = 0$ the system has a bounded closed dissipativity region $\Omega_x = \{x : F(x) \leq K\}$

where $F(x)$ – continuous, piecewise-smooth, positive-definite function in R^n such that, for some $\varepsilon > 0$ and $\mu_0 > 0$ the inequality

$$\sup_{\mu_i \leq \mu_0} \left[\left(\frac{\partial F}{\partial x} \right)^T f(x, \mu_1, 0) \right] \leq -\varepsilon \quad \text{at } F(x) = C,$$

then for all sufficiently small $\mu_1, \mu_2 \leq \mu_0$ the set Ω_x remains the domain of dissipativity of the system (D.2).

The system of equations (15) is autonomous, so this lemma can be applied to it. Suppose $\mu_2 = 0$ in (D.1). Then we get

$$\begin{aligned} \dot{\varepsilon}(t) &= A_m \varepsilon(t), \quad e(t) = L_1 \varepsilon(t), \\ \mu_1 \dot{\eta}(t) &= \Gamma \eta(t), \quad \Delta(t) = \bar{\zeta}(t) - \zeta(t) = \mu_1^{\gamma-1} \eta_1(t) = \mu_1^{\gamma-1} L_1 \eta(t), \end{aligned} \quad (\text{D.3})$$

whence we have $\lim_{t \rightarrow \infty} \varepsilon(t) = 0, \lim_{t \rightarrow \infty} \eta(t) = 0$. Therefore, the following relations

hold $\lim_{t \rightarrow \infty} Y(t) = Y_m(t), \lim_{t \rightarrow \infty} \bar{\Delta}(t) = 0, \lim_{t \rightarrow \infty} \xi(t) = 0$ where

$Y_m^T(t) = [y_m(t) \ y_m'(t) \ \dots \ y_m^{\gamma-1}(t)]$. From the equations

$$\dot{\varepsilon}_b(t) = A_m \varepsilon_b(t) - b q_m^T \xi(t), \quad e_b(t) = L_1 \varepsilon_b(t), \quad \zeta(t) = \varepsilon(t) - \varepsilon_b(t)$$

following $\lim_{t \rightarrow \infty} \varepsilon_b(t) = \lim_{t \rightarrow \infty} \zeta(t) = 0$.

Consider a function $\chi(t)$, that is a generalized perturbation

$$\chi(t) = -\omega((r_0 \alpha - 1) q_m^T \xi(t) + CY(t) - T\sigma(t) + G\varphi(t) + \psi(t)) + Q_\gamma(P) y_m(t),$$

$$\dot{\sigma}(t) = D\sigma(t) + By(t), \quad \dot{\varphi}(t) = D\varphi(t) - Bq_m^T \xi(t).$$

From conditions $\lim_{t \rightarrow \infty} Y(t) = Y_m(t), \lim_{t \rightarrow \infty} \bar{\Delta}(t) = 0, \lim_{t \rightarrow \infty} \xi(t) = 0$ it follows, that the

vector $\sigma(t)$ is limited and $\lim_{t \rightarrow \infty} \varphi(t) = 0$. Taking into account the third condition

of the assumptions, we can conclude that the function $\chi(t)$ is bounded in the absence of switching. If the switching of the elements of the ω matrix is instantaneous, then the $Y(t)$ $\sigma(t)$ $\varphi(t)$ $\psi(t)$ r_0 vectors are multiplied by other constants. Hence, there will be limited jumps. In the case when the control is switched off for a while during switching, i.e. there is some time for the switching elements to operate, short pulses will appear. This is due to the fact that in this mode the trajectory of the state vector of the control object will deviate due to the control being turned off.

Thus, we have obtained that for $\mu_2 = 0$, all variables in a closed system are bounded. In this case, the quadratic Lyapunov function

$$V(\varepsilon, \eta) = \varepsilon^T(t)H\varepsilon(t) + \eta^T(t)\Phi\eta(t) \quad (D.4)$$

satisfies the conditions of the lemma, where positive-definite matrices are defined by their matrix equations

$$HA_m + A_m^T H = -\rho_1 I_\gamma, \quad \Phi F + F^T \Phi = -\rho_2 I_\gamma, \quad \rho_1 > 0, \rho_2 > 0 \quad (D.5)$$

Since the conditions of the lemma are satisfied, there exists a number μ_0 such that when the inequalities $\mu_1 < \mu_0$, $\mu_2 < \mu_0$, hold, all variables of system (15) are bounded values. However, the boundedness of all variables does not guarantee the fulfillment of the target conditions (2). Let us find out the area of attraction of the original system, assuming that $\mu_1 = \mu_2 = \mu_0$. Let us calculate the derivative of the function (D.4) on the trajectories of the system (D.3), taking into account (D.5)

$$\dot{V}(\varepsilon, \eta) = -\rho_1 |\varepsilon(t)|^2 + 2\mu_0^{\gamma-1} \varepsilon^T(t)Hbq_m^T \bar{\Delta}(t) - \frac{\rho_2}{\mu_0} |\eta(t)|^2 + 2\eta^T(t)\Phi b\zeta^\gamma(t)$$

Let's use the ratings:

$$2\mu_0^{\gamma-1} \varepsilon^T(t)Hbq_m^T \bar{\Delta}(t) \leq \mu_0^{\gamma-1} |\varepsilon(t)|^2 + \mu_0^{\gamma-1} k_1, \quad 2\eta^T(t)\Phi b\zeta^\gamma(t) \leq \frac{1}{\mu_0} |\eta(t)|^2 + \mu_0 k_2$$

where $k_1 = \sup_t |Hbq_m^T \bar{\Delta}(t)|^2$, $k_2 = \sup_t |\Phi b\zeta^\gamma(t)|^2$. Then we get the following inequality

$$\dot{V}(\varepsilon, \eta) \leq -(\rho_1 + \mu_0^{\gamma-1}) |\varepsilon(t)|^2 - \frac{\rho_2 - 1}{\mu_0} |\eta(t)|^2 + \mu_0^{\gamma-1} k_1 + \mu_0 k_2 \quad (D.6)$$

It is obvious that there are numbers ρ_1, ρ_2, μ_0 ensuring the positivity of the numbers $(\rho_1 + \mu_0^{\gamma-1})$ and $\frac{\rho_2 - 1}{\mu_0}$. In this case, from (D.6) we will have an estimate

of the attraction area $(\rho_1 + \mu_0^{\gamma-1}) |\varepsilon(t)|^2 + \frac{\rho_2 - 1}{\mu_0} |\eta(t)|^2 \leq \mu_0^{\gamma-1} k_1 + \mu_0 k_2$, whence

follows the chain of inequalities $|y(t) - y_m(t)| \leq |\varepsilon(t)| \leq \sqrt{\frac{\mu_0(\mu_0^{\gamma-2} k_1 + k_2)}{\rho_1 + \mu_0^{\gamma-1}}}$.

It follows from this inequality that there is a number μ_0 , that ensures the fulfillment of the target condition (2).

4. Example

To illustrate the results obtained, consider system (1) consisting of three subsystems, in which

$$A_1 = \begin{bmatrix} 3 & 1 & 0 \\ 3 & 0 & 1 \\ 3 & 0 & 0 \end{bmatrix}, B_1 = \begin{bmatrix} 1 \\ 9 \\ 9 \end{bmatrix}, A_2 = \begin{bmatrix} 1 & 1 & 0 \\ 2 & 0 & 1 \\ 2 & 0 & 0 \end{bmatrix}, B_2 = \begin{bmatrix} 0 \\ 5 \\ 6 \end{bmatrix}, A_3 = \begin{bmatrix} 4 & 1 & 0 \\ 4 & 0 & 1 \\ 4 & 0 & 0 \end{bmatrix}, B_3 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix},$$

$$D = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix}, \Gamma_1 = \begin{bmatrix} 1 \\ 2 \\ 2 \end{bmatrix}, \Gamma_2 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}, \Gamma_3 = \begin{bmatrix} 0 \\ 1 \\ 3 \end{bmatrix}, L = [1 \ 0 \ 0], f(t) = \sin t + \sin 2,2t,$$

$y_m(t) = 2 \sin t + 2 \sin 0,7t$. All subsystems are unstable and have different relative degrees, the largest of them is equal to two. Therefore, we take an auxiliary circuit, which is described by the equation

$$P^2 e_b(t) + 11P e_b(t) + 30e_b(t) = 10v(t), u(t) = 2v(t), e(t) = y(t) - y_m(t),$$

$$\zeta(t) = e(t) - e_b(t),$$

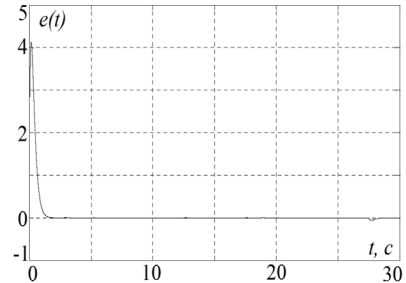
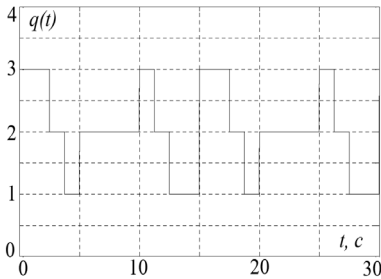
$$v(t) = -0.1(30\xi_1(t) + 11\xi_2(t) + 30\xi_3(t)), \text{ where estimates of the deriva-}$$

tives of the signal $\zeta(t)$ are obtained from the observer

$$\dot{\xi}_1(t) = \xi_2(t) + \frac{9}{\mu}(\zeta(t) - \xi_1(t)), \dot{\xi}_2(t) = \xi_3(t) + \frac{12}{\mu^2}(\zeta(t) - \xi_1(t)),$$

$$\dot{\xi}_3(t) = \frac{9}{\mu^3}(\zeta(t) - \xi_1(t)), x^T(0) = [2, 2, 2], \text{ the rest of the initial conditions}$$

are zero, $\mu = 0,01$.



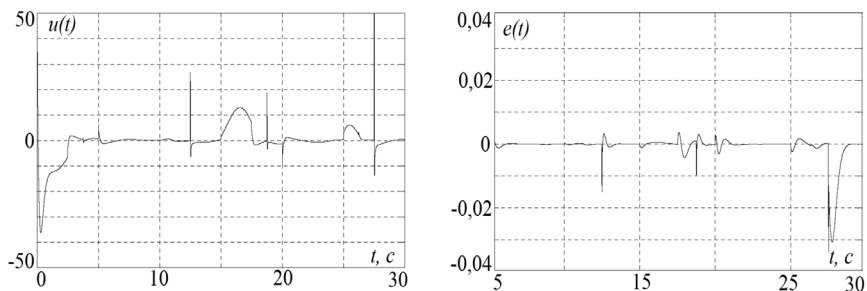


Figure 1. Transition processes

The control action is limited $|u(t)| \leq 50$. The switching signal $q(t)$ takes the values 1, 2, 3. Accordingly, parameters with this number are connected. On fig. 1 shows transients for error and control, as well as a graph of the change in the function $q(t)$, which controls the switching of parameters. It can be seen from the figure that the maximum bursts of the error signal during switching do not exceed 0.04. The appearance of bursts is due to the fact that an observer with a large gain is used to estimate the derivatives. However, if we compare this value with the amplitude of the reference signal, which is equal to four, then we get a very small value of the relative tracking error.

5. Conclusion

The transformation of the mathematical model of the control object to the form when switchings are considered as parametric disturbances, as well as the application of the approach of constructing robust control systems [16, 17], made it possible to obtain a tracking system in which the generalized disturbance is suppressed, resulting in a system with a sufficiently small tracking error. The result obtained can be easily generalized to systems with delay, as well as to a sufficiently large class of nonlinear systems. The disadvantage of the proposed method is the fact that it is not possible to obtain an analytical dependence of the tracking error on the parameters of the control device. However, this obstacle is easily overcome at the stage of system modeling.

References

1. Mourik S., Zwart H., Keesman K.J. Switching input controller for a food storage room // *Control Engineering Practice*. – 2010. – Vol. 18. – N. 5. – P. 507–514.

2. Hespanha J.P. Root-mean-square gains of switched linear systems // *IEEE Trans. Autom. Control.* – 2003. – Vol. 48. – N. 11. – P. 2040–2045.
3. Hespanha J.P., Morse A.S. Switching between stabilizing controllers // *Automatica.* – 2002. – Vol. 38, – N. 11 – P. 1905–1917.
4. Daafouz J., Riedinger P., Jung C. Stability analysis and control synthesis for switched systems: a switched Lyapunov function approach // *IEEE Trans. Autom. Control.* – 2002. – Vol. 47. – N 11. – P. 1883–1887.
5. Zhai, G. Xu X. A unified approach to analysis of switched linear descriptor systems under arbitrary switching // *Int. J. of Applied Mathematics Computer and Science.* – 2010. – Vol. 20. – N. 2. – P. 249–259.
6. Geromel J., Colaneri P.C. Stability and stabilization of continuous-time switched linear systems // *SIAM Journal Contr. and Optim.* – 2006. – Vol. 45. – N. 5. – P. 1915–1930.
7. Tianrui L., Dong Y., Wanjun L. Exponential stabilization for a class switched neutral nonlinear time-delay systems // *Int. J. Sensing, Computing & Control.* – 2014. – Vol. 4. – N. 2. – P. 49–58.
8. Galbusera L., Bolzern P., Deaecto G. S., Geromel J. C. Output feedback stabilization of time-delay switched linear systems // *Preprints of the 18th IFAC World Congress.* – 2011. – P. 1279–1284.
9. Hespanha, J., P. Uniform stability of switched linear systems: extensions of lasalle's invariance principle // *IEEE Tran. Autom. Control.* – 2004. – Vol. 49. – N. 4. P. 470–482.
10. Zattoni E., Perdon A.M., Conte G. Disturbance decoupling with stability in continuous-time switched linear systems under dwell-time switching // *Preprints of the 19th IFAC World Congress.* – 2014. – P. 164–169.
11. Deaecto, G.S., Geromel, J.C., Daafouz, J. Dynamic output feedback H_∞ control of switched linear systems // *Automatica.* – 2011. – Vol. 47. – N. 8. – P. 1713–1720.
12. Pakshin P.V., Pozdyaev V.V. Criterion for the existence of a general quadratic Lyapunov function of a set of second-order linear systems // *Bull. RAS. Theory and control systems.* – 2005. – № 4. – P 22–27.
13. Aleksandrov A. Yu., Kosov A. A., Chen Ya. On the stability and stabilization of mechanical systems with switching // *Automation and Telemechanics.* – 2011. – № 6. – P. 5–17.
14. Vasiliev S. N., Kosov A. A. Analysis of the dynamics of hybrid systems using general Lyapunov functions and multiple homomorphisms // *Automation and Telemechanics.* – 2011. – № 6. – P. 27–47.
15. Aleksandrov A. Yu., Zhabko A. P., Zhabko I. A. Kosov A. A. Investigation of stability and stabilization of non-linear switchable mechanical systems based

on decomposition // Mechatronika, avtomatizatsiya, upravlenie. – 2015. – Volume 16. – № 12. – P. 807–811.

16. Tsykunov A. M. Robust Control Algorithm with Compensation of Limited Disturbances // Automation and Telemechanics. – 2007. – №7. – P. 103-115.

17. Tsykunov A.M. Robust control of linear objects with switching // Problems of control. – 2017. - №4. – P.2-7.

18. Khalil H. K. Nonlinear systems. – M.: – Izhevsk. – 2009. – 832 P.

19. Brusin V. A. On one class of singularly perturbed adaptive systems // Automation and Telemechanics. – 1995. – №4. – P. 119-127.

沿水平井筒(钻孔)的热流运动数学模型的开发
**DEVELOPMENT OF A MATHEMATICAL MODEL OF HEAT
FLOW MOVEMENT ALONG A HORIZONTAL WELLBORE
(BOREHOLE)**

Al-Qadasi Omar Khaled Abduljalil Ahmed

Lecturer

Ufa State Petroleum Technological University

摘要: 本文制定并介绍了水平钻孔中的水动力和热物理流动模型。研究了过渡带流体密度失配对储层动态的影响。研究了相互作用相密度变化 0–10% 对气油和油水接触的影响。

关键词: 石油; 气体; 水; 流体动力学; 热物理学; 水平井; 油藏建模。

Abstract. *The hydrodynamic and thermophysical flow models in a horizontal borehole are formulated and presented in the article. The influence of the mismatch of fluid densities in the transition zones on the reservoir performance was studied. The effect of changes in the density of interacting phases by 0-10% on gas-oil and oil-water contacts has been studied.*

Keywords: *oil; gas; water; hydrodynamics; thermophysics; horizontal well; reservoir modeling.*

The low permeability oil and gas resources are rich and have great potential all over the world, which has gradually become the main target of oil and gas field development. However, after traditional primary and secondary exploitation, there is still a large amount of oil that has not been recovered. Therefore, in recent years, enhanced oil recovery technologies for low permeability reservoirs have been greatly improved to further improve the recovery of crude oil. Since thermal recovery methods perform best in the extraction of heavy oil from hydrocarbon reservoirs, such methods would be preferable for oil recovery. These methods include cyclic injection of steam (especially carbon dioxide), hot water injection, and gravity drainage with steam.

Factors affecting accurate prediction of fluid contacts are hydrodynamic gradients, reservoir heterogeneities, presence of semi-permeable barriers, and flatness of the sandstone. Accurate determination of the initial liquid contact depth is essential to assessing reservoir flow performance. Theoretically, formation fluid

contacts are assumed to be horizontal, but this is not the case in typical formation conditions if the fluid contacts are non-linearly coupled. However, such a definition leads to large discrepancies in the estimation of reservoir fluid displacement and the overall productivity of hydrocarbon production.

Before presenting a thermophysical model of flow in a horizontal wellbore, it is necessary to formulate a hydrodynamic model.

Hydrodynamic flow model in a horizontal wellbore.

Partial differential equations of an oil emulsion model were used for the study using the Eclipse 100 simulator, a product of the Schlumberger service company. Its application was based on the number and type of simulated phases. Here the water flows together with the hydrocarbon phase (oil and gas). In contrast, when using a compositional model, both oil and gas are treated separately, in contrast to an emulsion, which assumes that liquid and gaseous hydrocarbons flow as one phase. The emulsion model equation is fundamental, cumulative for multiphase flow control and is the mathematical basis on which the simulation model is built [1].

Equations (1), (2), (3) below describe an extended emulsion model in which ϕ , S_H , S_G and S_B represent porosity, oil, gas, and water saturation, respectively. Variables B_H , B_G , B_B describe the reservoir volume ratio (RB/STB) for oil, gas and water, respectively. The reservoir volume factor is included in the simulation to correlate the surface fluid flow with the prevailing reservoir conditions. Although R_v and R_s presented in equations (1), (2), (3), describe the ratio of the volume of oil to the volume of gas under standard conditions, and the reverse is true for R_s . When modeling an emulsion, the relative velocity of phases through a porous medium is taken into account, which is represented as Darcy velocities \vec{u}_H , \vec{u}_G and \vec{u}_B measured in meters/day for oil, gas and water phases, respectively.

$$\frac{d}{dt} \left[\phi \left(\frac{S_H}{B_H} + \frac{R_v S_G}{B_G} \right) \right] + \nabla \cdot \left(\frac{1}{B_H} \vec{u}_H + \frac{R_v}{B_G} \vec{u}_G \right) = 0 \quad (1)$$

$$\frac{d}{dt} \left[\phi \left(\frac{S_B}{B_B} \right) \right] + \nabla \cdot \left(\frac{1}{B_B} \vec{u}_B \right) = 0 \quad (2)$$

$$\frac{d}{dt} \left[\phi \left(\frac{S_G}{B_G} + \frac{R_s S_H}{B_H} \right) \right] + \nabla \cdot \left(\frac{1}{B_G} \vec{u}_G + \frac{R_s}{B_H} \vec{u}_H \right) = 0 \quad (3)$$

Equations (4), (5), (6) represent the components in the direction of the x ordinate, taking into account the Darcy velocities

$$u_{xH} = -K_x N_H \frac{d}{dx} \left[P_H = \frac{\rho_H g_{kp}}{144 g_{kp}} \right] \quad (4)$$

$$u_{xG} = -K_x N_G \frac{d}{dx} \left[P_G = \frac{\rho_G g_{kp}}{144 g_{kp}} \right] \quad (5)$$

$$u_{xB} = -K_x N_B \frac{d}{dx} \left[P_B = \frac{\rho_B g_{kp}}{144 g_{kp}} \right] \quad (6)$$

where g_{kp} – critical gravitational attraction, m/s^2 .

The relative mobility N_i is defined as the ratio of the relative permeability for the phase flow to its viscosity, therefore,

$$N_i = \frac{K_i}{\mu_i} \quad (7)$$

Phase densities are related to gas solubility coefficients and reservoir volume using equations (8-10)

$$\rho_H = \frac{1}{B_H} [\rho_{Hsc} + R_{HS} g_{sc}] \quad (8)$$

$$\rho_B = \frac{1}{B_B} [\rho_{Bsc} + R_{BS} g_{sc}] \quad (9)$$

$$\rho_G = \frac{\rho_{Gsc}}{B_G} \quad (10)$$

Equations (11-13) represent the individual compressibility of oil, water and gas, respectively, measured in $1/psi$, where ϕ – is rock porosity and S_l – is phase saturation. In addition, saturation satisfies the expression presented in equation (14).

$$C_H = \phi \rho_{Hsc} \frac{S_H}{B_H} \quad (11)$$

$$C_B = \phi \rho_{Bsc} \frac{S_B}{B_B} \quad (12)$$

$$C_G = \phi \rho_{Gsc} \left[\frac{S_G}{B_G} + R_{HS} \frac{S_H}{B_H} + R_{BS} \frac{S_B}{B_B} \right] \quad (13)$$

$$S_H + S_G + S_B = 1 \quad (14)$$

Combining the equations described above results in a mass conservation equation for each fluid component. Equations (17-20) represent the mass conservation equations used by the emulsion simulator to simulate the flow of an oil component in the oil phase, a water component in the water phase, and a gas component in the oil, water, and gas phases, respectively.

$$-\left[\frac{d}{dx}\left(\frac{\rho_{HSC}}{B_H}u_{xH}\right) + \frac{d}{dy}\left(\frac{\rho_{HSC}}{B_H}u_{yH}\right) + \frac{d}{dz}\left(\frac{\rho_{HSC}}{B_H}u_{zH}\right)\right] - q_H = \frac{d}{dt}\left(\phi\rho_{HSC}\frac{S_H}{B_H}\right) \quad (15)$$

$$-\left[\frac{d}{dx}\left(\frac{\rho_{BSC}}{B_B}u_{xB}\right) + \frac{d}{dy}\left(\frac{\rho_{BSC}}{B_B}u_{yB}\right) + \frac{d}{dz}\left(\frac{\rho_{BSC}}{B_B}u_{zB}\right)\right] - q_B = \frac{d}{dt}\left(\phi\rho_{BSC}\frac{S_B}{B_B}\right) \quad (16)$$

$$-\left[\frac{d}{dx}\left(\frac{\rho_{rsc}}{B_r}u_{xH} + \frac{R_{HS}\rho_{rsc}}{B_H}u_{xH} + \frac{R_{BS}\rho_{rsc}}{B_B}u_{xB}\right)\right] \quad (17)$$

$$-\left[\frac{d}{dy}\left(\frac{\rho_{rsc}}{B_r}u_{yH} + \frac{R_{HS}\rho_{rsc}}{B_H}u_{yH} + \frac{R_{BS}\rho_{rsc}}{B_B}u_{yB}\right)\right] \quad (18)$$

$$-\left[\frac{d}{dz}\left(\frac{\rho_{rsc}}{B_r}u_{zH} + \frac{R_{HS}\rho_{rsc}}{B_H}u_{zH} + \frac{R_{BS}\rho_{rsc}}{B_B}u_{zB}\right)\right] \quad (19)$$

$$-q_r = \frac{d}{dt}\left(\phi\rho_{rsc}\left[\frac{S_r}{B_r} + R_{HS}\frac{S_H}{B_H} + R_{BS}\frac{S_B}{B_B}\right]\right) \quad (20)$$

Thermophysical model of flow in a horizontal wellbore.

The non-stationary temperature field in the flow region is determined from the balance equation for the internal energy of a multiphase medium in the control volumes, taking into account the filtration rates \bar{w} , found above w based on the solution of the filtration equation. Assumptions apply: all phases (oil, water, rock) have the same temperature: $T_{ij}^B = T_{ij}^H = T_{ij}^{rn}$; the power of internal forces is negligible; the shape of the streamlines is known and is set during the calculation [2].

Internal energy balance equation in integral form

$$\int \frac{d}{dt}(\rho U) dV = - \int (\tau q^n + \rho U w_n) dS \quad (21)$$

where $\rho U = (\rho_B c_B + \rho_H c_H + \rho_{rn} c_{rn})$;

T – specific internal energy of a multiphase medium (oil, water, rock) per 1 m³ of volume;

τq^n – specific thermal energy per 1 m² of surface S , transmitted through the surface due to the mechanism of heat conduction;

$\rho U w_n$ – specific internal energy of a moving medium (oil, water) per 1 m².

The balance equation of internal energy in algebraic form for the control volume V_{ij} with $i = 1, \dots, N - 1, i = 1, \dots, M - 1$ will be written as

$$V_{ij}(\rho_B C_B + \rho_H C_H + \rho_{rn} C_{rn})_{ij}^{k+1} T_{ij}^{k+1} - (\rho_B C_B + \rho_H C_H + \rho_{rn} C_{rn})_{ij}^k T_{ij}^k = \quad (22)$$

$$\tau(\rho_B^k c_B^k w_B^{k+1} + \rho_H^k c_H^k w_H^{k+1})_{i-1,j} l_{1i-1,j} \Delta Z T_{i-1,j}^{k+1} - (\rho_B^k c_B^k w_B^{k+1} +$$

$$\rho_H^k c_H^k w_H^{k+1})_{ij} l_{1ij} \Delta Z T_{ij}^{k+1} + \tau(Q_{ij} + Q_{1ij} + Q_z')$$

$$\text{where } Q_{ij} = \lambda_{i+1,j}^k \frac{l_{1ij} \Delta Z}{h_{i+1,j}} (T_{i+1,j}^{k+1} - T_{ij}^{k+1}) - \lambda_{ij}^k \frac{l_{1i-1,j} \Delta Z}{h_{ij}} (T_{ij}^{k+1} - T_{i-1,j}^{k+1}) -$$

thermal energy per 1 m³ of volume, transferred through the faces $l_{1ij} \Delta Z$ and $l_{1i-1,j} \Delta Z$ of the control volume (between adjacent control volumes $j = \text{const}$).

The value of the heat flow through the boundary will be equal to the heat flow as a result of heat transfer from water to the walls of a horizontal well

$$-\lambda_1 \frac{T_1 - T_0}{h_1} = \alpha_B (T_B - T_0) \quad (23)$$

The value of the heat flow through 1 m² of the horizontal well section will be equal to

$$q_N = -\lambda_N \frac{T_N - T_{N-1}}{h_N} = \alpha_{H+B} (T_N - T_{H+B}) \quad (24)$$

The boundary conditions along the Y axis correspond to the absence of heat transfer at the lower boundary due to the symmetry of the problem being solved and are similar to equation (23) for the heat flow from the reservoir to the host rocks recorded for the upper boundary.

Accurate prediction of future reservoir performance is essential to determine the actual economic feasibility of a crude oil exploration and production project. Most often, in computational characterization and evaluation of the behavior of oil reservoirs over time, engineers attempt to approximate critical reservoir parameters derived from core analysis, well logging, geophysical surveys, and other data through computer simulations.

References

1. ChukwugozieJekwuEjehetal. *Effect of hydrodynamic tilting at fluid contacts to reservoir production performance.* –Direct text // *Results in Engineering, Volume 8, December 2020.*
2. Zhizhimontov I.N., ZemenkovYu.D., Shabarov A.B. *Non-stationary mass transfer of oil-water mixture in reservoirs with a system of horizontal well.* –Direct text // *IOP Conf. Ser.: Mater.Sci. Eng., 2020.*

DOI 10.34660/INF.2022.73.76.166

确保飞机产品制造质量和精度特性的因素的先验排序
**A PRIORI RANKING OF FACTORS TO ENSURE QUALITY AND
ACCURACY CHARACTERISTICS IN THE MANUFACTURE OF
AIRCRAFT PRODUCTS**

Zhilenko Vladislav Aleksandrovich

Undergraduate

Voronezh State Technical University

Krasnova Marina Nikolaevna

Candidate of Technical Sciences, Associate Professor

Voronezh State Technical University

摘要：本文考虑了确保飞机工业中质量精度特性的问题。

关键词：航空工业、航空装备产品、因素先验排序、保证质量和精度特性。

Abstract. *The paper considers the issue of ensuring quality-accuracy characteristics in the aircraft industry.*

Keywords: *aircraft industry, aviation equipment products, a priori ranking of factors, ensuring quality and accuracy characteristics.*

Airport security must always be at a high level. This applies to both airfield equipment and aircraft. After all, flight safety depends not only on the professionalism of pilots, but also on ground technical teams that are responsible for the state of aviation equipment.

That is why ground support personnel constantly conduct regular inspections and checks of aviation equipment.

In order to work at the airfields efficiently and efficiently, various service and control stations are used. But it is worth remembering that aircraft equipment should be inspected every time before departure in order to identify defects in the system. The fact is that transport malfunctions can lead to disastrous consequences.

This work is always performed by highly qualified workers who have more than one year of experience in this field. In order for the repair and maintenance of aircraft elements to be carried out at a high level, it is necessary to have the necessary knowledge and skills.

According to the established federal aviation rules, the engineering and technical service, in accordance with the maintenance regulations, is obliged to carry

out dismantling and assembly work of individual parts of aviation equipment units for various checks and diagnostics.

To date, it is hardly possible to find means of ground support for flights with equivalent wear of elements. The technological level of development of production has not yet reached its maximum. Although it is possible that similar details will appear in the future.

Today in army aviation there is a need to control the part “Blade turn lever” due to its large loads in flight, which is one of the constituent parts of the control system of the helicopter carrier system.

The casting process is very complex. When it is controlled, the results are determined by a large number of controlled and uncontrolled factors (the presence of defects). Some of the factors, due to their small influence on the value under study, cannot be controlled during the study. However, during experiments, these uncontrollable factors cause a spread in the values of the quantity under study, i.e. experiments repeated several times with the same values of controlled factors give results that differ from each other. In addition, the impact of each of the factors on the value under study is complicated by the influence of the interactions of factors. Therefore, recently, along with a deterministic description of foundry processes, they are increasingly considered from a probabilistic-statistical point of view, and experimental research uses methods of experiment planning based on the ideas of mathematical statistics and the mathematical theory of experiment [1].

The quality of the casting depends on the presence of various defects, which include shrinkage cavities, looseness, porosity, gas bubbles and cavities, sand cavities, slag cavities, non-metallic inclusions, metal inclusions, sinkholes, films, junctions, hot cracks, cold cracks, thermal cracks.

When deciding which method of X-ray or ultrasonic testing would better detect defects, it turns out to be dependent on many factors. As is known, the number of factors determines the number of experiments in a multifactorial experiment, and an increase in the number of factors included in the study leads to a significant increase in the amount of experimental work. As is known, the number of factors determines the number of experiments in a multifactorial experiment, and an increase in the number of factors included in the study leads to a significant increase in the amount of experimental work. For example, when conducting a full factorial experiment of type 2^k , an increase in the total number of factors by one unit entails a doubling of the number of experiments. So, with the number of factors equal to 5, it is necessary to carry out $2^5 = 32$ experiments, and with six factors, the number of experiments will be equal to $2^6 = 64$.

When establishing the dependence of process parameters on factors, in order to reduce the amount of experimental work, it is desirable to have as few of these factors under study as possible. However, it should be borne in mind that experiments

aimed at finding the optimal conditions for the course of the process may lose all meaning if at least one factor that has a significant effect on the optimization parameter is excluded from the number of factors.

Thus, with a large number of factors under study, they tend to reduce their number by eliminating such factors that have an insignificant effect on the process. To exclude, or screen out, factors that do not have a significant impact, it is necessary to know in advance which process factors and their interactions are the most significant, and which factors are of little significance. At the first stages of studying the process, if the researcher does not have data on the significance of factors, it is recommended to include in the study all the factors that can influence the process under study. It should be borne in mind that the theory of experiment has methods for distinguishing essential factors from the total number of system factors.

Known methods of experimental screening factors, involving a series of experiments and the selection of significant factors based on the results of these experiments. However, considering that even a small reduction in the number of factors significantly reduces the amount of subsequent experimental work, it is also necessary to use a priori information to filter out factors: literature data, results of a survey of specialists, etc. On the basis of a priori information, an a priori ranking of factors is performed, which makes it possible to single out the most significant factors and filter out factors that have an insignificant effect. At the stage of preliminary study of an object or process, it is possible to conduct a priori ranking, which consists in an objective assessment of the data obtained as a result of a survey of specialists or from studies published in the literature [1]. Such an analysis allows the most reasonable to exclude some factors from further consideration.

Usually, a priori ranking of factors is carried out in the following sequence. Based on the literature data, a list of factors influencing the parameter under study is compiled, and the domain of definition of each of the factors is established. Then they offer specialists working in this field to arrange the factors in a row according to the degree of their influence. At the same time, each specialist can supplement the list if, in his opinion, it is not complete or express an opinion on changing the variation intervals. When selecting specialists, it is necessary to strive for the presence among them of representatives of the largest possible number of scientific schools. When collecting opinions, each of the specialists is invited to fill out a questionnaire that lists the factors, their dimensions and the expected ranges of variation. Filling out the questionnaire, the specialist determines the place of the factors in the ranked series.

The contribution of each factor is estimated by the value of the rank-place assigned by the specialist to this factor when ranking all factors, taking into account their expected influence. The factor to which the leading role is attributed is given

the first place, the rest are arranged in descending order of the degree of their influence on the selected parameter. If it is difficult to determine the prevailing influence of some factor over another, then they are assigned the same ranks, which are the arithmetic mean of their estimated sum of ranks. The results of a survey of specialists are presented in the form of a matrix of ranks (tab. 1) [7].

Factors of influence on the possibility of UST and X-ray testing on cast body castings:

XRT	UST
1. Distance from tube focal spot to workpiece	6. Complex shape associated with different surface curvature and variable thickness in different areas of the part
2. Forms of the defect and its location relative to the direction of transillumination	7. Presence of irregular structural reflectors
3.Characteristics of the film and the correctness of its photo processing after exposure	8. Complex shape of discontinuities leading to strong scattering of the acoustic field.
4.The use of intensifying screens	9. Coarse-grained structure that degrades UST efficiency due to significant attenuation of ultrasound
5. X-ray hardness, thickness and density of the translucent material	10. Increased requirements for the state of the control surface for roughness and waviness

For example, four specialists were asked to rank eight factors (x_1, x_2, \dots, x_8). The first specialist arranged the factors according to the degree of their influence in the following sequence: $x_5, x_6, x_7, x_3, x_2, x_1, x_4, x_8$. In accordance with this sequence, factor x_5 is assigned rank 1, factor x_6 - rank 2, etc. The results of the survey of specialists are shown in tab. 1. The survey data is processed as follows. For each factor find the sum of ranks, $\sum_{j=1}^m a_{ij}$ and where m — number of experts interviewed; a_{ij} — the rank of the i -th factor assigned by the j -th researcher. Then the deviation Δ_i of the sum of ranks from the average sum of ranks for each of the factors is calculated:

$$\Delta_i = \sum_{j=1}^m a_{ij} - \frac{1}{k} \sum_{i=1}^k \sum_{j=1}^m a_{ij}, \quad (1)$$

where Δ_i - deviation of the sum of ranks of the i -th factor from the average sum of ranks;

k - number of factors;

$\frac{1}{k} \sum_{i=1}^k \sum_{j=1}^m a_{ij}$ - average sum of ranks.

Table 2
Matrix of ranks

Researchers	Ranks by factors							
	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈
1	6	5	4	7	1	2	3	8
2	7	8	6	4	2	1	3	5
3	4	5	8	7	1	3	2	6
4	6	8	7	5	1	2	4	3
Sum of ranks $\sum_{j=1}^m a_{ij}$	23	26	225	23	5	8	12	22
Deviation Δ_1 of the sum of ranks from the average sum of ranks	5	8	7	5	-13	-10	-6	4
Deviation squares Δ_i^2	25	64	49	25	169	100	36	16

So, for example, for the first factor x_1 , the sum of ranks will get the value $\sum_{j=1}^m a_{ij} = 6+7+4+6=23$; for factor x_2 it will be equal to $\sum_{j=1}^m a_{ij} = 5+8+5+8=26$ and etc.

In this example, the average sum of ranks for eight factors will be

$$\frac{1}{k} \sum_{i=1}^k \sum_{j=1}^m a_{ij} = \frac{1}{8} (23 + 26 + 25 + 23 + 5 + 8 + 12 + 22) = 18.$$

We find for each of the factors the deviation Δ of the sum of ranks from the average sum of ranks. Deviation Δ_1 of the sum of ranks of the first factor from the average sum of ranks

$$\Delta_1 = \sum_{j=1}^m a_{1j} - \frac{1}{k} \sum_{i=1}^k \sum_{j=1}^m a_{ij} = 23 - 18 = 5$$

Deviation Δ_2 of the sum of ranks of the second factor from the average sum of ranks

$$\Delta_2 = \sum_{j=1}^m a_{2j} - \frac{1}{k} \sum_{i=1}^k \sum_{j=1}^m a_{ij} = 26 - 18 = 8$$

Having determined the values of Δ_i for each of the factors, the degree of agreement between the opinions of the interviewed specialists is assessed. For this, the concordance coefficient W is used, which is calculated by formula (2) [1].

$$W = \frac{12S}{m^2(k^3 - k)}, \quad (2)$$

where $S = \sum_{i=1}^k \Delta_i^2$.

In the example under consideration, the concordance coefficient is equal to

$$W = \frac{12S}{m^2(k^3 - k)} = \frac{12(25 + 64 + 49 + 25 + 169 + 100 + 36 + 16)}{4^2(8^3 - 8)} = 0,72.$$

It has been established that for $k > 7$ the value $m(k-1)W$ obeys the χ^2 - distribution with the number of degrees of freedom $f = k - 1$.

The significance of the concordance coefficient W is determined using the Pearson test. To do this, find the calculated value χ_p^2 according to the formula (3)

$$\chi_p^2 = m(k-1)W = \frac{125}{mk(k+1)}. \quad (3)$$

The calculated value χ_p^2 is compared with the tabulated value from the Pearson distribution found for the accepted level of significance and the number of degrees of freedom $f = k - 1$. The hypothesis of the agreement of the opinions of the interviewed specialists is accepted if $\chi_p^2 \geq \chi_t^2$

In the given example, $\chi_p^2 = m(k-1)W = 4(8-1)0,72 = 20,2$. At a 5% significance level ($\alpha = 0,05$) and the number of degrees of freedom $f = k - 1 = 8 - 1 = 7$ the tabular value χ_t^2 is 14,1. Since $\chi_p^2 > \chi_t^2$, then we can assume that the opinions of experts are consistent.

After making sure that the opinions of experts are consistent, you can build a rank diagram. When constructing this diagram, the factors are plotted along the abscissa in ascending order of the sum of the ranks, and along the ordinate - the sum of the ranks.

For the example under consideration, the rank diagram is shown in fig. 1. In this figure, the shaded part of the diagram characterizes the degree of influence of factors on the value under study. The degree of influence of the factor on the value under study is estimated by the value of the sum of ranks: the smaller the sum of the ranks of the factor, the greater the effect it has on the value under study.

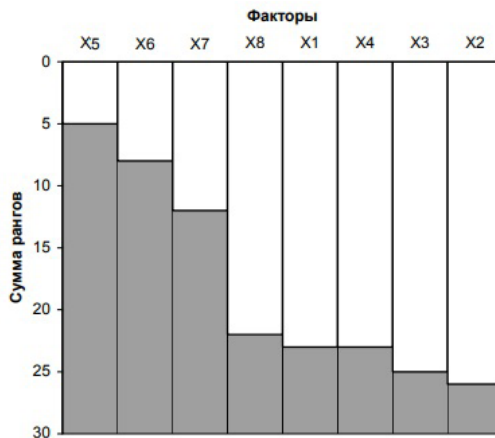


Figure 4.1. Rank chart

Using the rank diagram, you can highlight the most influencing factors and weed out factors that have an insignificant impact. If the distribution of the degree of influence of factors is uniform or uneven, but monotonically decreasing (fig. 2, a), this means that all factors must be included in the further study of the process. In the case of a rapid exponential drop in the degree of influence of factors (fig. 2, b), some of the factors can be excluded from further study of the process.

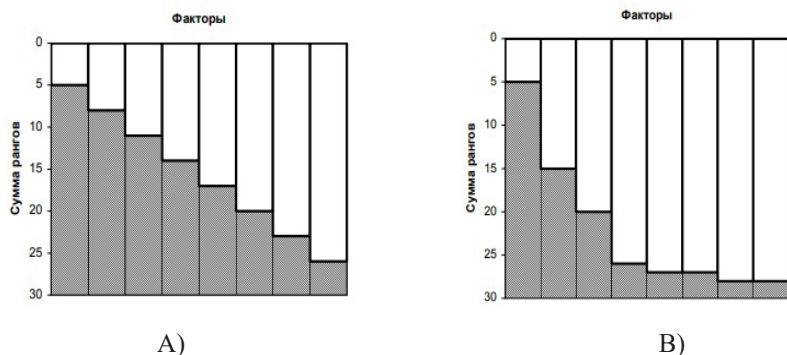


Figure 2.2. Rank diagrams

It follows from the rank diagram that, according to the interviewed specialists, the factors that influence the test result more than others are the hardness of X-rays and the thickness of the product during X-ray testing, and the complexity of the shape and the presence of irregular reflectors affect the ultrasonic testing. Other factors have a much smaller influence, and they can be excluded from further consideration.

References

1. *Optimization of metal technology processes by methods of planning experiments*; Novik Yu.P., Arsov Ya. B.-M.: mechanical engineering; Sofia: Technique, 1980. – 304 P.
2. *Non-destructive testing and diagnostics: a reference book* / V.V. Klyuev and others; ed. V.V. Klyuev. – 3-rd ed., rev. and add. – M.: Mechanical Engineering, 2005. – 656 P.

复合预防药物“Cesamin”的毒理学评价
**TOXICOLOGICAL EVALUATION OF THE COMPLEX
PROPHYLACTIC DRUG “CESAMIN”**

Gavrilov Yuri Anatolyevich

Doctor of Biological Sciences, Full Professor

Far Eastern State Agrarian University, Blagoveshchensk, Russia

Gavrilova Galina Antonovna

Doctor of Veterinary Sciences, Full Professor

Far Eastern State Agrarian University, Blagoveshchensk, Russia

Kruchinkina Tatiana Viktorovna

Candidate of Veterinary Sciences

*Far Eastern Zonal Research Veterinary Institute, Blagoveshchensk,
Russia*

摘要: 这项工作的目的是确定基于天然沸石制备的复合制剂的急性、慢性和亚慢性毒性。该药物包括抗菌剂和调节仔猪体内代谢过程的药剂。

在体重为 180–200 的白鼠身上测定了药物的急性和慢性毒性。在确定急性毒性时,将药物与白面包混合喂养。初始剂量为 1.12 g/kg,两天后翻倍。在确定慢性毒性时,药物以 1.0 g/kg 体重的剂量喂食 60 天。在断奶仔猪中测定亚慢性毒性,这些仔猪以 1.0 g/kg 动物体重的剂量与饲料一起给药 30 天。在确定药物毒性的过程中,观察动物,考虑它们的行为、一般状况、对食物的态度、被毛状况和可见粘膜。

为了评估实验组和对照组动物体内的形态学和生化变化,在实验结束之前和之后,在大鼠中采集血液 – 通过乙醚麻醉后断头,从尾静脉抽取小猪。测定血液中红细胞数、白细胞数、血红蛋白数、白细胞配方。通过蛋白质、碳水化合物-脂质和矿物质代谢的状态评估代谢过程的变化。已确定该药物对白鼠没有急性和慢性毒性;对断奶仔猪的亚慢性毒性。给仔猪喂食预防药物 30 天伴随着代谢过程的正常化,内源性中毒过程的减少,并防止消化系统疾病。

使用预防性药物 30 天可预防腹泻综合征胃肠道疾病的发展,而对照组中 30% 的仔猪患有此类疾病。

关键词: 预防性药物,沸石,大鼠,仔猪,急性,慢性,亚慢性毒性。

Abstract. *The purpose of the work is to determine the acute, chronic and subchronic toxicity of a complex preparation made on the basis of natural zeolites. The drug includes an antimicrobial agent and agents that regulate metabolic processes in the body of piglets.*

Acute and chronic toxicity of the drug was determined on white rats weighing 180-200. When determining acute toxicity, the drug was fed mixed with white bread. The initial dose was 1.12 g/kg, which was doubled after two days. When determining chronic toxicity, the drug was fed at a dose of 1.0 g/kg of body weight for 60 days. Subchronic toxicity was determined in piglets of weaning age, which were given the drug at a dose of 1.0 g/kg of animal weight for 30 days with feed. During the determination of the toxicity of the drug, the animals were observed, their behavior, general condition, attitude to food, condition of the coat and visible mucous membranes were taken into account.

To assess the morphological and biochemical changes in the body of animals of the experimental and control groups, blood was taken before and after the end of the experiments, in rats - by decapitation after ether anesthesia, in piglets from the tail vein. In the blood, the number of erythrocytes, leukocytes, hemoglobin, leukocyte formula was determined. Changes in metabolic processes were assessed by the state of protein, carbohydrate-lipid, and mineral metabolism.

It has been established that the drug does not have acute and chronic toxicity for white rats; subchronic toxicity to weaned piglets. Feeding a prophylactic drug to piglets for 30 days is accompanied by the normalization of metabolic processes, a decrease in the processes of endogenous intoxication, and prevents digestive disorders.

The use of a prophylactic drug for 30 days prevents the development of disorders of the gastrointestinal tract with diarrheal syndrome, while 30% of piglets in the control group have such disorders.

Keywords: *prophylactic drug, zeolites, rats, piglets, acute, chronic, subchronic toxicity.*

Introduction

One of the reasons for the loss of young pigs after weaning are diseases of the digestive system, both non-contagious and infectious nature [7, 9, 3]. In recent years, a wide range of drugs (antimicrobial, probiotic drugs) has been proposed for the treatment and prevention of gastrointestinal diseases in piglets [6, 1, 11]. However, the use of antimicrobial drugs, in particular broad-spectrum antibiotics, is accompanied by the rapid development of resistance to them in opportunistic microflora.

Natural zeolites are used to prevent or reduce the negative effect of ecotoxins coming with feed on the organism of farm animals. As catalysts and ion exchangers, zeolites contribute to better feed digestibility and are a source of micro- and macroelements, which is important for young pigs, which are characterized by a high degree of growth. Zeolites have a pronounced effect on the microflora of the gastrointestinal tract [4], help reduce the processes of endogenous intoxication [10], and are effective in the pathology of the digestive organs in young pigs [2].

In connection with the foregoing, we have developed a complex prophylactic preparation based on natural zeolites of the Vanginsk deposit [5] with the inclusion of antimicrobial agents and agents regulating metabolic processes in the body of piglets.

The purpose of the work – is to determine the acute, chronic and subchronic toxicity of the complex drug.

Material and research methods

Determination of acute and chronic toxicity of the drug was carried out according to the guidelines for experimental (preclinical) study of new pharmacological substances [7]. As a model object, 2-month-old male white outbred rats weighing 180–200 were used. Subchronic toxicity was determined on piglets of 2-month-old white large breed. All procedures and experiments on rats and piglets were carried out in accordance with international rules for the treatment of animals.

When determining acute toxicity, the prophylactic drug was fed to rats mixed with white bread. The initial dose of the drug was 1.12 g/kg, which was doubled after two days. To determine chronic toxicity, the drug was given for 60 days at a dose of 1.0 g/kg.

The determination of subchronic toxicity was carried out on piglets for 30 days, the dose of the drug was 1.0 g/kg of body weight. The drug was given in the morning feeding mixed with food.

During the determination of the toxicity of the drug, the animals were observed, their behavior, general condition, attitude to food, condition of the coat and visible mucous membranes were taken into account.

To assess the morphological and biochemical changes in the body of animals of the experimental and control groups, blood was taken before and after the end of the experiments - in rats by decapitation after ether anesthesia, in piglets from the tail vein. In the blood, the number of erythrocytes, leukocytes, hemoglobin, leukocyte formula was determined. Changes in metabolic processes were assessed by the state of protein, carbohydrate-lipid, and mineral metabolism.

Results and discussion

The inclusion of the drug in the diet of rats at an initial dose of 1.12 g/kg of body weight had no effect on the general condition of the animals. The rats ate the food completely, were mobile, and actively reacted to external stimuli. The animals ate the drug at a dose of 2.24 g/kg of body weight completely, no changes in behavior were found. In the following days, the dose of the drug was increased, while the rats actively took food, water, and showed a lively reaction to external stimuli. The drug at a dose of 11.52 g/kg of weight was completely consumed by the experimental rats, no changes were found in the behavior of the animals: they actively took food and water, reacted to external stimuli.

The rats did not completely eat the drug at a dose of 23.04 g/kg, 8.972 ± 1.61 g/kg of the drug per animal remained in the feeders, while the rats showed no signs of intoxication - they were mobile, actively reacting to external stimuli. Confirmation of the absence of signs of acute intoxication is evidenced by hematological parameters of rats of the experimental and control groups (tab. 1).

Table 1
Hematological parameters of rats in the study of the inclusion of a prophylactic drug in an acute experiment (n=10)

Indicators	Test	Control
Red blood cells, $10^{12}/l$	$6,48 \pm 0,43$	$7,56 \pm 0,29$
Leukocytes, $10^9/l$	$9,90 \pm 1,27$	$10,3 \pm 0,60$
Hemoglobin, g/l	$104,20 \pm 6,57$	$92,0 \pm 8,10$
Lymphocytes, %	$82,4 \pm 1,60$	$80,6 \pm 2,33$
Basophils, %	-	-
Eosinophils, %	-	$1,3 \pm 0,88$
Monocytes, %	-	$0,6 \pm 0,33$
Neutrophils, %		
Segmented, %	$11,8 \pm 1,06$	$12,8 \pm 3,05$
Stab-cells, %	$4,2 \pm 0,8$	$4,0 \pm 1,15$
Young, %	-	$0,6 \pm 0,33$

Hematological parameters of rats of the experimental and control groups do not have statistically significant differences, therefore, the drug does not have acute toxicity.

The inclusion of a complex preparation in the diet of rats at a dose of 1.5 g/kg of body weight for 60 days did not reveal signs of chronic toxicity. During the experimental period, the rats completely ate food, the mucous membranes of the oral cavity are pink, the coat is smooth and shiny. Confirmation of the absence of chronic intoxication when feeding the complex preparation is evidenced by the biochemical parameters of the blood of rats of the experimental and control groups (tab. 2).

From table 2 it follows that feeding the drug to rats for 60 days does not affect the content of total protein in the blood serum, however, in rats of the experimental group, the content of albumin is 14.2% higher than in the control, albumin-globulin coefficient (A/G) 1.3 times higher in the experimental group. The inclusion of a prophylactic drug in the diet of rats does not affect the content of macronutrients calcium and inorganic phosphorus in the blood serum.

Table 2

Biochemical and hematological parameters of the blood of rats after 60 days when feeding the drug in a chronic experiment (n=10)

Indicators		Test	Control
Total protein, g/l		80,6±1,47	80,1±1,92
Albumins, %		44,2±2,75	38,7±3,36
Globulins, %	α	19,1±0,96	21,9±1,44
	β	21,0±1,55	22,7±1,90
	γ	15,6±1,52	16,7±1,99
A/G		0,82±0,09	0,63±0,08
Urea, mmol/l		5,13±0,18	4,52±0,49
Cholesterol, mmol/l		1,64±0,11	1,42±0,38
Glucose, mmol/l		5,28±0,30	4,74±0,45
Calcium total, mmol/l		1,63±0,01	1,47±0,04
Phosphorus inorganic, mmol/l		2,51±0,18	3,23±0,57
MDA, mmol/l		3,52±0,21	4,40±0,23
ASAT, units/l		30,3±2,39	39,5±4,55
ALAT, u/l		21,4±0,33	23,1±1,08
Lysozyme, %		86,3±1,97	87,3±0,33
Hemoglobin, g/l		136,9±2,87	129,0±11,93
Red blood cells, 10 ¹² /l		5,37±0,24	5,44±0,53
Leukocytes, 10 ⁹ /l		13,7±1,20	11,3±1,85

Feeding the drug to rats for 60 days is accompanied by a decrease in the level of malondialdehyde (MDA) by 1.25 times compared with the control group, which indicates the antioxidant properties of the drug.

The activity of transamination enzymes of aspartate, alanine aminotransferases (AsAT, ALAT) in the experimental group is lower than in the control, which indicates the hepatoprotective properties of the drug.

Morphological parameters of the blood of rats of the experimental and control groups do not have significant differences.

It was not possible to determine the average lethal dose (LD₅₀) since there was no death of rats from taking the drug at a maximum dose of 23.04 g/kg of body weight.

The inclusion in the diet of weaned piglets of a prophylactic drug at a dose of 1.0 g/kg of body weight for 30 days contributed to the normalization of metabolic processes (tab. 3). The data in table 3 show that the content of total protein in the blood serum of the piglets of the experimental group by the end of the experiment increased by 5.1 g/l, in the control it decreased by 3.4 g/l. At the same time, in the composition of the total protein, the piglets of the experimental group have a higher content of albumins compared to the control.

An increase in the amount of albumin in the blood serum indicates an increase in the protein-synthetic function of the liver. Confirmation of this assumption is the decrease in the level of aminotransferases in the blood serum of piglets of the experimental group of piglets compared to the control. A high level of urea in the blood serum of piglets indicates a high breakdown of feed protein in the gastrointestinal tract. The inclusion of a prophylactic drug in the diet is accompanied by a decrease in this indicator by 14%, which is probably due to the inhibition of opportunistic microflora by the antibacterial component of the drug.

The prophylactic drug does not affect lipid metabolism; at the same time, an increase in glucose levels by 37% was found in the experimental group compared to the initial state.

Table 3
Biochemical and hematological parameters of piglet blood when using a prophylactic drug

Indicators	Before the start of the experience		After 30 days	
	Test (n=22)	Control(n=12)	Test (n=21)	Control (n=11)
Total protein, g/l	62,0±1,84	70,0±3,60	67,1±1,63	66,6±2,40
Albumins, %	40,7±1,79	35,5±1,17	36,5±3,02	32,1±3,44
α-globulins, %	19,2±1,77	23,2±1,17	17,9±1,24	16,1±3,08
β-globulins, %	14,4±1,32	19,8±2,57	24,2±2,17	26,2±2,86
γ-globulins, %	25,6±1,88	21,1±2,77	21,1±1,57	25,4±3,77
A/G, units	0,69±0,05	0,54±0,03	0,59±0,08	0,47±0,07
Urea, mmol/l	5,26±0,66	6,16±1,00	4,52±1,03	6,16±0,42
Glucose, mmol/l	4,62±0,46	7,29±0,85	6,33±0,21	6,03±0,59
Tot. lipids, mmol/l	2,12±0,13	2,64±0,38	2,33±0,13	2,31±0,06
Cholesterol, mmol/l	2,46±0,13	2,81±0,39	3,17±0,40	2,74±0,20
Calcium, mmol/l	1,77±0,04	1,89±0,38	2,47±0,28	1,66±0,14
Inorg. phosphorus, mmol/l	2,21±0,21	2,48±0,34	2,49±0,37	2,99±0,04
MDA, mmol/l	3,85±0,38	3,74±0,45	2,91±0,73	3,71±0,62
OMD, nmol/l	2,27±0,19	2,63±0,51	1,99±0,13	2,87±0,15
ASAT, units/l	38,4±3,86	43,0±1,33	23,3±2,61	39,4±0,98
ALAT, u/l	35,4±3,18	42,3±10,31	25,4±2,84	37,2±0,99
MWM, opt. den. un.	0,311±0,05	0,276±0,01	0,059±0,005	0,171±0,02

Feeding a prophylactic drug to piglets for 30 days is accompanied by an increase in total calcium in blood serum by 40% compared with the initial state, probably due to the normalization of digestion processes. The level of inorganic

phosphorus in the blood serum of piglets in the initial state exceeds the physiological norm by 13-27%, and during the experiment its level does not change.

The inclusion of a prophylactic drug in the diet of piglets for 30 days helps to reduce the processes of lipid peroxidation and oxidative modification of proteins, which is confirmed by a decrease in the level of malondialdehyde in the experimental group by 1.3 times, while unchanged - in the control. A decrease in oxidatively modified proteins (OMP) by 1.14 times compared with the initial state was noted.

The basis of the prophylactic preparation is the natural zeolites of the Vanginsk deposit, which have a high absorption capacity. Due to these properties, the prophylactic drug helps to reduce endogenous intoxication, as evidenced by a decrease in the level of medium-weight molecules (MWM) by 5.2 times in the experimental group compared to the initial state.

The use of a prophylactic drug for 30 days prevents the development of gastrointestinal disorders, while 30% of piglets in the control group have digestive disorders. During the experimental period, the piglets of the experimental group were mobile, actively fed, and reacted vividly to external stimuli.

Studies have established the absence of acute and chronic toxicity in the drug for white rats and subchronic - for weaned piglets. The drug contributes to the normalization of metabolic processes in piglets when used for 30 days.

References

1. Andreeva A.V., Muratova E.T. Colonization resistance of the intestines of piglets under weaning stress and their correction / veterinary medicine. Modern problems and development prospects: Proceedings of the international scientific-practical conference / Sarat. state agrarian un-ty. n.a. N. I. Vavilov. – Saratov. 2010. – P. 14-17.
2. Velikanov, V. V. The use of enterosorbents in the pathology of the digestive organs in young pigs / V. V. Velikanov, A. P. Kurdeko, V. A. Lapina // Scientific notes of the educational institution “Vitebsk Order of the Badge of Honor” State Academy of Veterinary Medicine” : scientific and practical journal. – Vitebsk, 2013. – V. 49, iss. 1, part 1. – P. 7-10.
3. Gavrilov Yu. A. Etiology of gastroenteritis in young farm animals in the conditions of the Amur Oblast // Kuryatova E.V., Gerasimova M.V., Tyukavina O.N., Gavrilova G.A. / Far Eastern Agrarian Bulletin, 2018. №1. – P. 60-67.
4. Idiatullin F.I. Prospects for the use of sorbents in pig breeding / F.I. Idiatullin // Materials of sci.—ind. conferences on topical issues of veterinary medicine and zootechnics. - Kazan, 2001. Part 2. – P. 240-241.

5. Complex drug “Cesamin” for the prevention of gastrointestinal diseases in piglets Pat. 2665617 Russian Federation, IPC A61R1/100, A61K35/74, A61R31/00, A61D 99/00 / Yu.A. Gavrilov, N.Yu. Wild, T.V. Kruchinkina / applicant and patentee Dalnevost. zones. sci.-res. veterinar. in-ty. Pub. 03.09.2018, Bul. № 25.
6. Novak M.D., Engashev S.V. The effectiveness of complex antibiotics containing ciprofloxacin, tiamulin and apramycin in respiratory and intestinal diseases of piglets and chickens / International scientific journal “innovative science” / 2015. - №12. - P. 183-185.
7. Parshin P.A. Clinical and morphological characteristics and therapy of factorial diseases of the digestive organs of piglets //P.A. Parshin, M.V. Vyskub, V.I. Parshina, S.M. Suleimanov, V.E. Abramov, P.A. Anufriev / Veterinary pathology. – 2009, № 4. – P.130-133.
- 8 Guide to the experimental (preclinical) study of new pharmacological substances / under. gen. ed. R.U. Khabrieva. – M.: “Medicine”, 2005 – 832 P.
9. Savelyeva L.N. On the issue of gastrointestinal disorders in piglets and the damage caused to pig breeding of the Trans-Baikal Krai / L.N. Savelyeva, A.A. Kudelko, M.L. Bondarchuk, T.S. Maltsev /International Research Journal. - 2016, № 11 (53) – Part 2. - P. 161-165.
10. Yu. A. Gavrilov, G.A. Gavrilova. Efficiency of using zeolites enriched with trace elements and elemental sulfur to correct endogenous intoxication in cows ///E3S Web of Conferences / ed.: A. Muratov, S. Ignatieva : EDP Sciences (France), 2020. Vol. 203: Ecological and Biological Well-Being of Flora and Fauna (EBWFF-2020). P01001. – P. 105-106.
11. M.S. Rodionova. Treatment of piglet gastroenteritis //E3S Web of Conferences / ed.: A. Muratov, S. Ignatieva : EDP Sciences (France), 2020. Vol. 203: Ecological and Biological Well-Being of Flora and Fauna (EBWFF-2020). P01001. – P. 97-99.

萨拉托夫地区小麦产量对农林业和矿质营养的依赖

**DEPENDENCE OF WHEAT YIELD ON AGROFORESTRY AND
MINERAL NUTRITION IN THE CONDITIONS OF THE SARATOV
REGION**

Panfilov Andrey Vladimirovich

Doctor of Agricultural Sciences, Full Professor

Popov Valery Gennadievich

Doctor of Agricultural Sciences, Full Professor

Mariskin Roman Valerievich

Postgraduate

*Saratov State University of Genetics, Biotechnology and Engineering
named after N.I. Vavilov, Russia, Saratov*

抽象的。 本文研究了小麦籽粒产量的形成、矿物肥料影响下的小麦品质以及伏尔加草原林带系统的构建问题。 LP对小气候因素和春小麦产量影响的揭示模式可用于精准农业系统,以提高作物生产力并减少资源。 回归-相关分析表明,对春小麦产量影响最大的是施肥剂量和透孔,其次是施肥剂量和距林带的距离,最小的是透孔和距林带的距离。

关键词: 小麦, 产量, 矿物质营养, 农林业, 回归。

Abstract. *The paper examines the issue of the formation of wheat grain yield, its quality under the influence of mineral fertilizers and the construction of a system of forest strips in the Volga steppe. The revealed patterns of the influence of LP on microclimatic factors and the yield of spring wheat can be used in the precision farming system to increase the productivity of crops and reduce resources. Regression-correlation analysis revealed that the greatest influence on the yield of spring wheat is the dose of fertilizers and openwork, then the dose of fertilizers and the distance from the forest strip and the least – the openwork and the distance from the forest strip.*

Keywords: *wheat, yield, mineral nutrition, agroforestry, regression.*

Introduction

Grain production is a priority direction for the development of the crop industry of the steppe Volga region. The leading grain crop of the Saratov region is wheat, including spring wheat, which played an important role in the gross grain harvest

of 6.3 million tons in wet 2017. The most important factors in increasing the yield of wheat grain are chemical and forest reclamation. In the farms of the Right Bank of the Saratov region, unique objects of completed systems of protective forest strips have been created, the purpose of which is to improve the microclimate of adjacent fields and increase the productivity of crop rotation crops. [1. 4, 5, 6, 7].

Research methods

The experiment in 2015-2017 was conducted according to a three-factor scheme. Fertilizer doses: A1 – without fertilizers; A2 - N60P60K20 (140 kg/ha); A3- N60P90K60 +N30 (tubing, 220 kg /ha); in wet 2017, the experiment option was tested with a dose of fertilizers A4- N90P90K40 + N45 (tillering) + N45 (earring) (310 kg /ha); for which the plots of the A3 variant were divided in half by 25 m² (5x5). Terms of application: P and K-for winter, N- fractional in spring and during the growing season. The PZLP designs were formed according to the VNIALMI methodology [3]. The laying, carrying out, processing of experimental data were carried out according to BA. Armor [2].

The soil of the experimental site is southern medium loamy black soil unwashed and slightly washed on heavy loams. The thickness of the soil horizons A+B = 0.6-0.7 m with humus content in the horizon A - 3.9-4.2% (Table 1). The depth of groundwater is 15-20 m with a total mineralization of up to 1.2 g/l.

Forest strips contribute to the acidification of soil solutions both in the plantation itself and near it (the pH of the water extract is 6.9-7.0, respectively, at the control of 7.4).

Table 1
Agrochemical properties of southern chernozem

Observation point	Sampling depth, cm	Genetic Horizon	Humus, %	pH water extraction	Mobile forms, mg/kg		
					N ₂	P ₂ O ₅	K ₂ O
Forest strip	2-30	A	4,39	6,9	8,7	11,0	337
	31-80	B	2,81	7,0	7,7	6,9	340
3H	0-25	A	4,20	7,1	9,0	12,0	321
	26-70	B	2,77	7,3	8,1	6,8	315
10H	0-23	A	3,93	7,2	9,6	10,5	311
	24-60	B	2,50	7,4	8,0	5,8	311
Control, 25 H	0-22	A	3,90	7,4	8,4	9,5	309
	23-60	B	2,46	7,6	8,0	4,0	301

H- protective height of the forest strip (H=8m)

According to the Saratov weather station, the average annual precipitation is 410 mm with an oscillation amplitude of 250-668 mm . The least precipitation falls from December to April (112 mm), and the bulk falls in June-July in the form of showers (87 mm). During the warm period (April-October), precipitation varies between 200-350 mm. The wind rose is generally dominated by western and

north-western directions, bringing precipitation, dry winds - south and south-east directions. The average number of days in a year with blizzards is 29 days, and with dry winds is 19.

The formation of a stable snow cover is observed by the end of November – beginning of December, and it lies until the first decade of April, which is a period of 120-127 days. Precipitation for the period December-March is about 101 mm, which corresponds to 25% of the annual norm, the average annual water supply in snow in spring is 80 mm.

A comparison of three years of research (2015-2017) showed that in the average years for the humidification of the growing season of spring wheat, the effect of LP designs and fertilizers is approximately the same, with some advantage of fertilizers – by 4.7-7.3%. In wet years, the advantage of fertilizer exposure over the LP design increases by 7.3-67.7%.

On average, over the years of research (2015-2017), the increase in the yield of spring wheat under the influence of optimal LP designs increased by 2.4%, fertilizers – by 0.5%, together – by 3.0%. In wet years, in accordance with soil moisture reserves, it is necessary to increase the dose of mineral fertilizers in the form of top dressing during the growing season of spring wheat cultivation.

The dynamics of wheat yield is largely determined by the design of forest strips. The openwork, in turn, affects the microclimatic indicators of the crop field, and the effect depends on the moisture of the growing season of wheat cultivation.

In average humidification years, the greatest impact on wheat yield in the PPLP system is caused by air humidity (p) ($R^2 = 0.93$) - Fig., water balance deficit (d) ($R^2 = 0.70$). This is indicated by a decrease in the coefficient of determination and a significant increase in the average absolute deviation and the average absolute error as a percentage when excluding this factor from the data model. The third most important factor is the air temperature (t) in the surface layer ($R^2 = 0.59$). A slightly less significant influence is exerted by the distance from the PZSP H, and it has not only a linear, but also a quadratic term in terms of H.

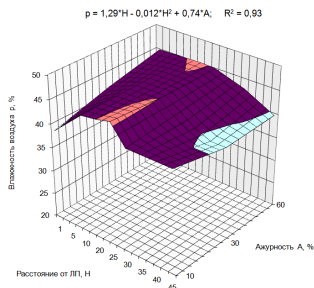


Figure. The dependence of the air humidity in a wheat field on the openwork and distance from the forest strip in the average humidification in 2015

In wet years, air temperature ($R^2=0.96$) has the greatest impact on wheat yield in the system of forest strips, followed by air humidity ($R^2=0.92$) and water deficit ($R^2=0.75$). The analysis allowed us to establish that the maximum impact on yield during the years of a stable cyclone with a low temperature is exerted by the product tA , which characterizes the mutual influence of air temperature and the tracery of the forest strip. Less important are the factors $t \cdot p$ (temperature and humidity), temperature and water deficit ($t \cdot d$). For the first time, we studied the effect of openwork and distance from the PPLP, time of day on the illumination of spring wheat crops. The measurement was carried out with a luxmeter-thermohygrometer TKA-PCM every two hours from 5 to 20 hours of the day on July 25, 2017 with a cloudless sky. Observations were carried out on the windward side of the PZLP at a distance of 0H (the edge of the forest strip), 1H, 3H, 5H, 10H. For the convenience of regression analysis, we used relative illumination, as the ratio of illumination under the influence of PPLP to the illumination of an open wheat field at an identical distance. Practically, the illumination of the crop from the windward side of the PPLP reaches the values of the open field by 9-10 o'clock in the morning with a coefficient of determination of the coupling of parameters 0.93. Wheat yield decreases at a distance from the PPLP to 1H, depending on the design and humidification of the growing season by 2.3-13.6%, on average by 8.0%. Regression-correlation analysis showed that the greatest impact on the yield of spring wheat, regardless of the moisture of the growing season in the system of forest strips, is the dose of fertilizers and openwork ($R^2 = 0.98$), then the dose of fertilizers and the distance from the LP ($R^2=0.76; 0.97$) and the smallest is the openwork and the distance from the LP ($R^2=0.63; 0.68$).

Conclusions

Form protective forest strips of blown construction, with the scheme: maple-oak-oak-maple; take a significant zone of reclamation influence of the system of forest strips on the microclimate and yield of spring wheat: for dense LP – 20N, openwork – 30N, blown – 40N; apply a dose of mineral fertilizers for spring wheat 220 kg / ha (N90P90K40): nitrogen – 90 kg/ha, phosphorus – 90 kg/ha, potassium – 40 kg/ha. During the wet growing seasons of cultivation of crops with moisture reserves in the soil of 75-80% HB, the dose of tuks increases to 310 kg / ha with an increase in nitrogen application in the form of two 45 kg/ha fertilizing -N180P90K40.

References

1. *Agroforestry / Ivanov A.L., Kulik K.N., Proezd P.N. and [others] VNIALMI, -olograd, 2006.- 746 p.*

2. Dospekhov, B. A. *Methodology of field experience* / B.A. Dospekhov. M., 1985.- 416s.

3. *Methodology of system studies of forest-agrarian landscapes*. VASHNIL, VNIALMI. M.,1985. - 112 p.

4. Mashtakov, D.A., Proezd, P.N. *The state of oak protective forest strips in the conditions of the southern chernozem steppe.* / D.A. Mashtakov, P.N. Proezd, etc. *Scientific life*. Moscow, Saratov, 2015 - No. 6. - pp. 143-156.

5. Proezd, P.N., Mashtakov, D.A. *Forest reclamation in the first quarter of the XXI century: historical milestones, concept, theory, experiment, practice, development strategy.*// *Bulletin of Saratov State Agrarian University named after N.I. Vavilov*. Saratov, SSAU named after N.I. Vavilov 2013, No. 8, pp. 24-29.

6. Proezd, P.N., Mashtakov, D.A. *Agroforestry (monograph).* / P.N. Proezdov, D.A. Mashtakov, A.V. Panfilov and [others]. SSAU named after N.I. Vavilov. Saratov, 2016. - 472 p.

7. Proezd, P.N., Panfilov, A.V., Mashtakov, D.A. *The influence of the system of forest strips on environmental factors and the yield of spring wheat in the steppe zone.* *Scientific life*. Moscow, Saratov, 2016 - No. 1. - pp. 36-43.

DOI 10.34660/INF.2022.28.22.169

伏尔加草原林带系统灌溉苜蓿的生产力
**PRODUCTIVITY OF IRRIGATED ALFALFA IN THE SYSTEM OF
FOREST STRIPS OF THE VOLGA STEPPES**

Popov Valery Gennadievich

Doctor of Agricultural Sciences, Full Professor

Panfilov Andrey Vladimirovich

Doctor of Agricultural Sciences, Full Professor

Lazarev Alexander Alexandrovich

Postgraduate

*Saratov State University of Genetics, Biotechnology and Engineering
named after N.I. Vavilov, Russia, Saratov*

抽象的。通过提高人工肥力的比例来补充自然肥力，效率低下。农业机械和林带使用的能源分析是基于生产 1 吨产品的能源消耗指标的比较。经济和能源评估表明，在生产结构的林带中以 13 公斤/公顷的播种量种植紫花苜蓿的优势。

最高的盈利水平对应于 13 公斤/公顷的苜蓿种子播种率，范围为 150.2% 至 188.3%，高于其他播种率 15.0% 至 39.1%。在净化结构的 LP 中苜蓿种子播种率为 13 kg/ha 的实验变体中获得了最高的能源效率系数。

关键词：苜蓿，播种率，生态，经济，资源保护，产量，能源。

Abstract. *The replenishment of natural fertility by increasing the specific proportion of artificial fertility has shown low efficiency. The energy analysis of the use of agricultural machinery and forest strips is based on a comparison of energy expenditure indicators in the production of 1 ton of products. The economic and energy assessment showed the advantage of cultivating alfalfa with a seeding rate of 13 kg/ha among the forest strips of the produced structure.*

The highest level of profitability corresponds to the alfalfa seed seeding rate of 13 kg/ha and ranges from 150.2 to 188.3%, which is higher at other seeding rates by 15.0 – 39.1%. The highest coefficient of energy efficiency was obtained on a variant of the experiment with a seeding rate of alfalfa seeds of 13 kg/ha among the LP of the purged structure.

Keywords: *alfalfa, seeding rate, ecology, economy, resource conservation, yield, energy.*

Bioenergetic assessment of the efficiency of the technology of cultivation of agricultural crops has recently become of great importance, which allows us to determine the payback of total energy costs with energy, as well as to identify the level of energy intensity of the resulting products. The programs implemented recently are orienting the Russian economy to increase or preserve resource consumption in the natural environment.

Measures to compensate for the decrease in natural fertility by increasing the specific share of artificial fertility have shown their low effectiveness. It should be noted that incorrect assessment of natural resources can significantly reduce the effects of an environmentally oriented economy and a resource-saving development model. Therefore, the most relevant is the use of the energy method, which complements and significantly expands the possibilities of economic analysis and contributes to a more competent justification of the impact of agrotechnical and agricultural techniques on obtaining additional profit by increasing the photosynthetic and productive potential of crop rotation crops.[1, 2, 3, 5, 6].

The variance and regression-correlation analysis was performed according to the professional version of standard computer programs and the methodology of B. A. Dospikhov [4]. The energy analysis was carried out according to the methods of the Institute of Agriculture [7, 8, 9].

The economic and energy assessment showed the advantage of cultivating alfalfa with a seeding rate of 13 kg/ha among the forest strips (LP) of the blown structure, despite the cost of seeds and the cost of care in planting (Tables 1, 2).

Table 1
Bioenergetic assessment of irrigated alfalfa under the influence of seeding rate and LP design

Seeding rates, kg/ha	Yield during the growing season, t/ha	Energy content in the crop, GJ/ha	Total energy costs for alfalfa cultivation, GJ/ha	Energy efficiency coefficient
Tight construction				
11	8,93	416,8	75,5	5,52
13	9,57	446,6	76,4	5,84
15	8,37	390,6	77,1	5,07
On average	8,95	418,0	76,3	5.48
Openwork design				
11	9,92	462,7	77,3	5,98
13	10,24	477,2	78,1	6,11
15	9,96	462,7	79,3	5,83
On average	10,04	467,5	78,2	5,98

Blown design				
11	10,48	494,9	76,6	6,46
13	11,38	532,6	77,5	6,87
15	10,16	485,6	78,7	6,17
On average	10,67	504,4	77,6	6,50

Observations show that the highest total energy content in the crop depends on the LP design with the advantage of blown LP compared to dense and openwork, respectively, by 19.2 and 11.5%. The energy costs of maintaining the LP construction by caring for plantings are compensated by the yield of alfalfa: the energy efficiency coefficient, regardless of the seeding rate, when using a blown LP structure is higher than dense and openwork, respectively by 18.6 and 8.7%.

It was found that as productivity increases, the profitability of alfalfa cultivation will increase: for a dense structure, it was 111.6 – 150.2%, openwork – 141.1 – 156.1% and blown – 149.2 – 188.3% (Table 2). The greatest profit in the cultivation of irrigated alfalfa in the LP system was obtained with a seeding rate of 13 kg/ha and a blown LP structure – 15.67 thousand rubles/ha, which is 29.4% more than with a dense structure.

Table 2
Economic efficiency of alfalfa cultivation depending on the seeding rate and the design of forest strips

Seeding rates, c/ha	Hay yield		Costs, thousand rubles/ha	The cost of production, thousand rubles/ha	Profit, thousand rubles/ha	Profitability level,%
	t/ha	t k units/ha				
LP canvases						
11	8,93	4,38	7,79	18,83	11,04	141,7
13	9,57	4,69	8,06	20,17	12,11	150,2
15	8,37	4,10	8,33	17,63	9,30	110,6
On average	8,95	4,38	8,06	18,83	10,77	134,5
Openwork LP						
11	9,92	4,86	8,22	20,90	12,68	154,2
13	10,24	5,02	8,43	21,59	13,16	156,1
15	9,96	4,88	8,70	20,98	12,28	141,1
On average	10,04	4,92	8,45	21,16	12,71	150,4
Blown LP						
11	10,48	5,14	8,05	22,10	14,05	174,5
13	11,38	5,58	8,32	23,9	15,67	188,3

15	10,16	4,98	8,59	21,41	12,82	149,2
On average	10,67	5,23	8,32	22,49	14,17	170,3

Notes: 1. 1 ton of alfalfa hay feed contains 0.49 tons of k units of oats;

The highest level of profitability corresponds to the alfalfa seed seeding rate of 13 kg/ha and ranges from 150.2 to 188.3%, which is higher at other seeding rates by 15.0 – 39.1% (Table 2). The highest costs for growing alfalfa were obtained among the openwork LP design, which involves additional felling of crown care, as opposed to dense and blown. The maximum profitability of alfalfa cultivation is typical for the LP of the blown structure with a seeding rate of 13 kg / ha, which is higher in comparison with dense and openwork, respectively, by 32.2 – 38.1%. On average, regardless of the rate of sowing alfalfa seeds, the blown structure is the most cost-effective: 19.9 - 35.8% (Table 2).

Regression-correlation analysis showed that 99% of the energy efficiency coefficient, showing the ratio of the total energy content in the crop to the energy costs of growing alfalfa, is due to crop yield, seed seeding rate and the construction of forest strips. Quadratic values of yield and alfalfa seed seeding rates had a negligible effect on the energy efficiency coefficients.

When growing alfalfa, energy efficiency does not depend on market conditions, therefore objectively evaluates the results of research. The highest coefficient of energy efficiency was obtained on a variant of the experiment with a norm of sowing alfalfa seeds of 4 million/ha (13 kg/ha) among the LP of the blown structure - 6.87, which is 17.6% and 12.4% more than dense and openwork, respectively. The same pattern persists with a seeding rate of 3.5 (11 kg/ha) and 4.6 million/ha (15 kg/ha). Energy costs per unit of alfalfa crop for hay at a seeding rate of 13 kg/ha on average for LP structures: dense – 8.52 GJ/t, openwork – 7.80 GJ/t, blown – 7.17 GJ/t, which is lower by 8.4 and 15.8%, respectively, compared with dense. Along with the economic one, an energy assessment is necessary. The latter does not depend on market conditions and most objectively reflects the profitability in the application of agrotechnical, forest reclamation.

References

1. *Agroforestry* / P. N. Proezdov, [and others] // edited by P. N. Proezdov. Saratov, .2016.473p.
2. Vorotnikov I.L., Kolotyryn K.P., Yakunin V.A. Minimization of ecological and economic risks in the implementation of agricultural projects based on insurance mechanisms // *Agrarian Scientific Journal*. - 2015. - No. 8. - pp. 75-80.

3. Vorotnikov I.L., Panfilov, K.P. Kolotyryn. *Improving the state of agro-landscapes in the system of environmental management economics* // *Izvestia of the Nizhnevolzhsky Agricultural University Complex: Science and Higher Professional Education*. 2013, No. 1. pp. 171-175.
4. Dospekhov, B. A. *Methodology of field experience*. Moscow. 1979. - 416 p.
5. Kolotyryn K.P., I.L. Vorotnikov, A.V. Panfilov. *Restoration of degraded agricultural landscapes taking into account ecological and economic factors.* // *Economics of agricultural and processing enterprises*. 2012. No. 4. pp.68-70.
6. Mashtakov D. A., Proezd P. N. *Economic and energy assessment of the cultivation of ku-kuruza under the influence of irrigation, chemical and forest reclamation in the dry-steppe Trans-Volga region,* // *Economics of Agriculture of the Russian Federation*. 2010, No. 10. pp.33-39.
7. *Methodology for determining the ecological capacity and bioenergetic potential of the territory of the agricultural landscape* / ed. by V.M. Volodin.-Kursk: Research Institute of Agriculture and Soil Protection from Erosion, -2000.-32 p.
8. *Methodology for optimizing the structure of land in the agricultural landscape on a bioenergetic basis* / ed. by V.M. Volodin.-Kursk: Research Institute of Agriculture and Soil Protection from Erosion, -2000.-52 p
9. Panfilov A.V., Proezd P.N., Irgiskin I. Yu. *Environmental risk management in agroforestry landscapes.* *Electronic Scientific Journal*, (78) UEX, No. 6, Access mode: <http://uecs.ru/index.php2015>.

伏尔加地区草原带不同农业景观类型的农林牧场耗水量

WATER CONSUMPTION OF AGROFOREST PASTURES BY TYPES OF AGRICULTURAL LANDSCAPE IN THE STEPPE ZONE OF THE VOLGA REGION

Panfilov Andrey Vladimirovich

Doctor of Agricultural Sciences, Full Professor

Popov Valery Gennadievich

Doctor of Agricultural Sciences, Full Professor

Motova Yulia Vladimirovna

Postgraduate

*Saratov State University of Genetics, Biotechnology and Engineering
named after N.I. Vavilov, Russia, Saratov*

抽象的。草场耗水量和生产力与农业景观的类型和开放程度密切相关。农业景观类型的主要指标之一是坡度，坡度决定了农田土壤肥力和生产力的高低。牧场的生产力和耗水量取决于土壤肥力水平、秋季水分、冬季积雪量、牧草生长季节的水分。

关键词：耗水量，农林业，农业景观，生产力。

Abstract. *Water consumption and productivity of grass pastures are closely related to the type and openness of the agricultural landscape one of the main indicators of the type of agricultural landscape is the slope slope, which determines the level of soil fertility and productivity of agricultural land. The productivity and water consumption of pasture lands depends on the level of soil fertility, autumn moisture, snowiness of winters, moisture of the growing season of pasture grasses.*

Keywords: *Water consumption, agroforestry, agricultural landscape, productivity.*

Introduction

An effective way to preserve fertility is to create forest strips as protective boundaries, and to conduct agro-reclamation techniques in the interstitial spaces. For 2008. In Russia, 2.47 million hectares of protective forest plantations (ZLN) have been preserved out of 5.2 million hectares created. It is necessary to have 7 million per ZLN to bring the forest cover to normalized indicators: arable land-2.5%, land-3.8%. Of the agro-reclamation techniques, mulched slitting turned out to be universal and conjugate. On pasture slopes 3-80 bush scenes have proven themselves reliably [1, 3, 5, 6, 8].

The purpose of the study is to develop forest-reclamation and agrotechnical techniques for increasing the productivity of natural grasses of eroded pastures by types of agro-landscape in the steppe of the Volga upland.

Research methodology. Research methodology

The research was carried out on 5 types of agricultural landscape with a complex of anti-erosion techniques: plakor (<10) and gentle hollow (1-30)-forest strips and cracks with mulch; sloping (3-50) and sloping-steep (5-80)-forest strips, shrubby wings; shafts; steep (>80)-protective plantings on terraces. The experiments were performed according to the methodology of VNIALMI, B.A. Dospekhov, A.N. Kostyakova. Covariance analysis using standard computer programs was used for mathematical processing of research materials[1, 3, 4, 5, 7].

Research results, discussion

The effectiveness of the anti-erosion and forest reclamation system is determined by the optimal placement of its elements in agricultural landscapes, the reliability of hydrological justification, and the availability of appropriate reclamation techniques.

The soils of the experimental site are southern chernozem, underdeveloped, crushed stone, medium loamy, from weakly-strongly washed on the flask. The thickness of soil horizons A+ B < 0.5 m with a humus content of 1.97-4.85%, depending on the type of agricultural landscape.

The created forest strips, shrub wings, protective plantings on steep-slope types of agricultural landscape (>80) with a preliminary arrangement of terraces are designed to contain soils at an acceptable level of erosion equal to 0.3 t/ha [7, 9].

Studies of the elements of the water balance of moisture availability and productivity were carried out by types of agricultural landscape, the characteristics of which were based on the steepness (slope) of the slope (Table 1). In the conditions of the arid climate of the South-East, the degree of their provision with moisture in all phases of plant development has a decisive influence on the productivity of agricultural lands [1,2,5,8].

Table 1
Fertility indicators of southern chernozem by types of agricultural landscape

Indicators power	Type of agricultural landscape				
	Slightly Flat, <1°	Gently sloping, 1-3°	Sloping, 3-5°	Pokato-cool, 5-8°	Cool, >8°(20°)*
Horizon Power A+B, cm	64/65	56/57	50/52	40/43	20/26*
Content in the horizon A:					

- Humus, %	4,69/4,85	4,08/4,26	3,79/4,07	3,21/3,56	1,97/2,33*
- N, mg/kg	20,7/27,2	18,1/24,3	13,1/17,9	10,1/15,3	5,1/11,1*
-P, mg/kg	23,1/32,7	20,7/29,1	16,9/21,2	11,2/17,6	6,9/12,8*
-K, mg/kg	329,3/347,1	303,4/329,6	248,4/275,6	171,0/205,3	140,7/174,6*
-NPK, mg/kg	373,1/407,0	342,2/383,0	278,4/314,7	192,3/238,2	152,7/198,6*

* Indicators on the bulk part of the terrace;

In the steppe zone in the spring after snowmelt, the soil to a depth of 1 m or more is often moistened to the lowest moisture capacity (HB), by the beginning of sowing - up to 70% HB, and by the time of harvesting reaches a dead reserve [2]. Analyzing the data of water reserves in snow for 2015-2018, it can be stated that on the eve of snowmelt there were two average snow (2014-2015 - 89-94 mm and 2016-2017- 77-91 mm) and two multi-snow winters (2015-2016-129-139 mm, 2017-2018-114-238 mm). Moreover, the winter of 2017-2018. it is noted as very snowy with snow height on pasture lands, depending on the type of agricultural landscape 64-70 cm.

Along with snow, the sediment of the vegetation period of plant regrowth (May-June) belongs to the formation of the grass harvest of pastures of the 1st mowing. Over 4 years of research, different years were observed for the humidification of the growing season: average (GTK= 0.69), medium-moist (GTK=0.81), humid (GTK=2.35), acutely arid (GTK=0.40). Drilling was carried out at intervals of 10 days to a depth of 1 m to determine the subsurface moisture reserves at the experimental sites, which made it possible to trace the movement of moisture to establish the water consumption of natural grasses and pastures. Under the influence of protective forest plantations, the highest moisture reserves in the soil were recorded, which were formed due to ascending water currents from the lower layers of the aeration zone-up to 35 mm. Moisture reserves at the beginning of grassland regrowth largely depended on autumn precipitation and the amount of snow under the influence of the SLN (agroforest landscape), and subsequently-precipitation during the growing season.

The productivity of pastures decreases under the influence of the type of agricultural landscape, regardless of the moistening of the year and the use of anti-erosion techniques: the decrease is 38.3-105.8%, and on average for 2015-2018 up to

64.2%. The decrease in the productivity of grasses is associated with a decrease in the level of soil fertility by types of agricultural landscape (slope steepness)-see table 1. A particularly sharp drop in the productivity of pasture grasses compared to lowland types of agricultural landscape (<30) occurs on steep slopes (200), because the potential (humus) and effective (NPK) soil fertility decreases. There is a very low content of nitrogen, phosphorus and potassium in the soil, including areas under the influence of 35-year-old ZLN. The average content of nitrogen, phosphorus and potassium in the soil is inherent in the sloping (3-50) and sloping (5-80) types of the agricultural landscape under the influence of HLS. The high (>30 mg/kg) nitrogen and phosphorus content in the soil was not recorded, which indicates a promising application of mineral fertilizers (Table 1).

Regardless of the moisture content of the growing season, the water consumption coefficient of pasture grasses increases with increasing slope steepness, especially on erosion-prone types of agricultural landscape (>30). Moreover, in a wet year, with an increase in the steepness of the slope, the coefficient of water consumption increases by 1.0-42.2%, in a dry year - by 11.9-66.3%, and on average for 2015-2018- by 5.7-61.0%. The coefficient of water consumption of pasture grasses under the influence of HLN, depending on the type of agricultural landscape, decreases in comparison with open terrain in wet years by 10.1-12.8% in dry years – by 28.3-32.3%. The lower value of the decrease in the coefficient of water consumption corresponds to erosion-hazardous types of agricultural landscape (> 30). On average, in 2015-2018, the decrease in the coefficient of water consumption with the same downward trend is 8.0-12.6%.

The coefficient of water consumption of grass pastures of 1-mowing is 99% due to the type and openness of the agricultural landscape, in other words, the slope (steepness) of the slope and the degree of protection of the slope of the ZLN.

Conclusion

The greatest accumulation of humus is characteristic of erosive types of agricultural landscape (>30): an increase in humus content -by 0.28-0.36%, nutrients (NPK)-by 13.0-30.0%. The productivity and coefficient of water consumption of grass pastures, depending on the type and openness of the landscape, is predetermined by soil fertility. The coefficient of water consumption increases with an increase in the slope slope, depending on the moisture content of the growing season of pasture grasses on erosive types of agricultural landscape by 4.8-66.3. The coefficient of determination equal to 0.99 indicates a very close relationship between water consumption and pasture grass productivity.

References

1. *Agroforestry*/edited by A.L.Ivanov, K.N.Kulik.//P.N.Proezdov, V.I.Petrov, A.S.Rulev, etc.-Volgograd: VNIALMI, 2006-748 p.
2. Byaly A.M. *Water regime in crop rotation on chernozem soils of the South-East/ A.M.Byaly.-L.: Hydrometeoizdat, 1971.-232 p.*
3. Grigoriev V.Ya. *How to evaluate the water-retaining capacity of crevice/V. Ya. PGrigoryev, M.S.Kuznetsov et al. //Melioration and water management.-1990.-No.2.pp.19-20.*
4. Dospekhov B.A. *Methodology of field experience. M.:Kolos, 1985.-358 p*
5. Kostyakov.A.N. *Fundamentals of land reclamation. –M., 1960.-622s.*
6. Kuznik I.A., Lysov A.V., Proezd P.N. *Erosion protection of soils. Volga upland: collection of scientific.Worksarat. SHI.-Saratov, 1977.-pp. 95-106.*
7. *Methodology of system studies of forest landscape. VASHNIL. Edited by E.S. Pavlovsky. VNIALMI.M., 1985.-112 p.*
8. Proezdov P.N., Mashtakov D.A., Kovalev A.N. *Patterns of water consumption of natural grassland under the influence of hydrotechnical and forest reclamation in the steppe landscapes of the Volga upland/ Bulletin of the Saratov State Agrarian University named after N.I.Vavilov, Saratov, SSAU, 2012, No. 2, pp.44-48.*

DOI 10.34660/INF.2022.42.74.171

不同总砷含量的斑点鲶鱼 (*Anarhichas minor*) 肌肉组织的代谢特征
**METABOLIC PROFILE OF THE MUSCLE TISSUE OF THE
SPOTTED CATFISH (*ANARHICHAS MINOR*) WITH DIFFERENT
CONTENTS OF TOTAL ARSENIC**

Kozin Andrey Valerievich

*Candidate of Chemical Sciences, Senior Research Officer
VNIRO Russian Federal Research Institute of Fisheries and
Oceanography*

Abramova Liubov Sergeevna

*Doctor of Technical Sciences, Full Professor, Deputy Head of
Department
VNIRO Russian Federal Research Institute of Fisheries and
Oceanography*

抽象的。对含有不同量总砷的鲶鱼 (*Anarhichas minor*) 样品的肌肉组织提取物的代谢特征进行了分析。主要代谢物通过 $^1\text{H-NMR}$ 光谱测定。鲶鱼肌肉组织水提取物中的代谢物已被鉴定和量化。已经确定,随着砷含量的增加,亮氨酸、异亮氨酸、缬氨酸、丙氨酸、谷氨酸、 β -丙氨酸、甘氨酸、鹅氨酸、核糖、尿苷、组氨酸的浓度有明显增加的趋势。酪氨酸、苯丙氨酸、蛋氨酸、二甲胺。使用主成分法,发现对于不同砷含量的鲶鱼,以下代谢物对代谢谱的变化做出了主要贡献:甘氨酸、 β -丙氨酸、谷氨酸和酪氨酸。

关键词: 核磁共振, 代谢物, 砷, 水生生物资源, 鲶鱼。

Abstract. *The analysis of the metabolic profile of muscle tissue extracts of catfish (*Anarhichas minor*) samples containing various amounts of total arsenic was carried out. The main metabolites were determined by $^1\text{H-NMR}$ spectroscopy. Metabolites in aqueous extracts of catfish muscle tissue have been identified and quantified. It has been established that with an increase in the content of arsenic, there is a clear trend towards an increase in the concentration of leucine, isoleucine, valine, alanine, glutamic acid, β -alanine, glycine, anserine, ribose, uridine, histidine, tyrosine, phenylalanine, methionine, dimethylamine. Using the method of principal components, it was found that for catfish with different arsenic content, the following metabolites make the main contribution to the change in the metabolic profile: glycine, β -alanine, glutamic acid, and tyrosine.*

Keywords: *NMR, metabolites, arsenic, aquatic bioresources, catfish.*

Introduction

Currently, the fishing industry faces a number of important tasks related to solving the problem of assessing the anthropogenic impact on the state of aquatic biological resources, developing objective methods for characterizing both the biological indicators of objects and confirming their quality from the standpoint of further food use. When solving these problems, foreign practice uses a wide range of analytical methods, as well as modern “omics” technologies: genomics, transcriptomics, proteomics and metabolomics. Fish as a biological living system is considered from the standpoint of a complex interaction of the flow of substances, energy and information between the four main levels - genome, transcriptome, proteome and metabolome. A special place is occupied by metabolomics, since the main area of research is devoted to the study of low molecular weight organic compounds - metabolites, both intermediate and end products of metabolism in body fluids and tissues. Metabolites are the most accurate reflection of the phenotype of an organism, and their systematic study (obtaining a metabolic profile) allows a better understanding of biochemical processes and a detailed differentiation of the stages of the corresponding chemical transformations when exposed to an aquatic organism [1].

NMR spectroscopy is one of the first analytical platforms used in metabolomics and is a fast and highly reproducible spectroscopy technique based on energy absorption and re-emission of atomic nuclei due to changes in external magnetic fields [2]. NMR makes it possible to detect a large number of endogenous metabolites in the body, and then obtain extensive information about the target samples [3]. The advantages of NMR are good stability and repeatability of detection results [4]. In addition, the sample pretreatment method based on the NMR metabolome is relatively simple, and the sample can be analyzed without destroying it [5].

In recent years, with the rapid development of industrialization, the issue of pollution of water bodies with heavy metals, such as cadmium (Cd), lead (Pb), mercury (Hg), arsenic (As), which cause serious harm to environmental organisms, and also pose a danger when use for food purposes [6-8]. The most acute problem is the increased content of total arsenic (As) and its compounds in fish raw materials [9]. With the accumulation of arsenic in the body, an increase in the content of phenylacetaldehyde and γ -aminobutyric acid was found, while the content of glutathione and alanine decreased, which indicates oxidative stress in the body, which results in a decrease in the metabolism of electrophilic compounds and a violation of DNA and protein synthesis.

In this regard, the aim of the work was to study the metabolic profile of the muscle tissue of catfish (*Anarhichas minor*) with different contents of total arsenic.

Materials and methods

The samples of catfish (*Anarhichas minor*) were used as objects of study, which were harvested immediately after the catch, frozen and delivered for re-

search to VNIRO. The content of arsenic was determined in the samples, which amounted to 4.2 mg/kg in sample № 311 - 4.2 mg/kg; № 312 - 9.5 mg / kg; № 313 - 47.5 mg / kg.

The main metabolites in the catfish muscle tissue were determined by NMR spectroscopy at the Shemyakin-Ovchinnikov Institute of Bioorganic Chemistry, RAS by obtaining aqueous extracts according to the procedure [10]. NMR spectra were recorded on a Bruker Avance III instrument (Bruker Biospin GmbH, Germany) with an operating proton frequency of 800 MHz at 303 K with a solution of TSP (3-trimethylsilyl[2,2,3,3-2H₄]sodium propionate) as an internal standard. The spectra were processed using TopSpin 3.6.1 software (Bruker BioSpin, Billerica, MA, USA). Metabolic profile results were analyzed using principal component analysis using the XLSTAT add-in for Microsoft Excel (XLSTAT version 2022.3.2, Addinsoft) and Origin Pro 2021 (OriginLab Corporation).

Results

One of the most important safety problems for a number of aquatic biological resources is the accumulation in muscle tissue of various forms of arsenic with different toxicity and degree of bioaccumulation [11, 12]. In this regard, studies are underway to assess the possible regulation of arsenic compounds, which pose the greatest danger in the use of products for food purposes. However, it is important to comprehensively determine the risks for introductory biological objects and their state at different levels of arsenic, to identify markers that characterize the biological state of fish at each stage of the life path.

For this purpose, studies of the metabolic profile of catfish samples were carried out, which contained different amounts of total arsenic: 4.2; 9.5 and 47.5 mg/kg by NMR spectroscopy. The analysis of ¹H-NMR spectra of extracts of muscle tissue of catfish samples was carried out (figure 1) and the content of the main metabolites was calculated. The quantitative content of identified metabolites for three catfish samples is shown in figure 2.

As can be seen from Figure 2, with an increase in the content of arsenic in catfish, there is a clear trend towards an increase in the concentration of leucine, isoleucine, valine, alanine, glutamic acid, β-alanine, glycine, anserine, ribose, uridine, histidine, tyrosine, phenylalanine, methionine, dimethylamine. It should be noted that for some metabolites there is no variability in the change in concentration, while for fumaric acid, creatine, trimethylamine-N-oxide and choline, a decrease in their content in muscle tissue is observed.

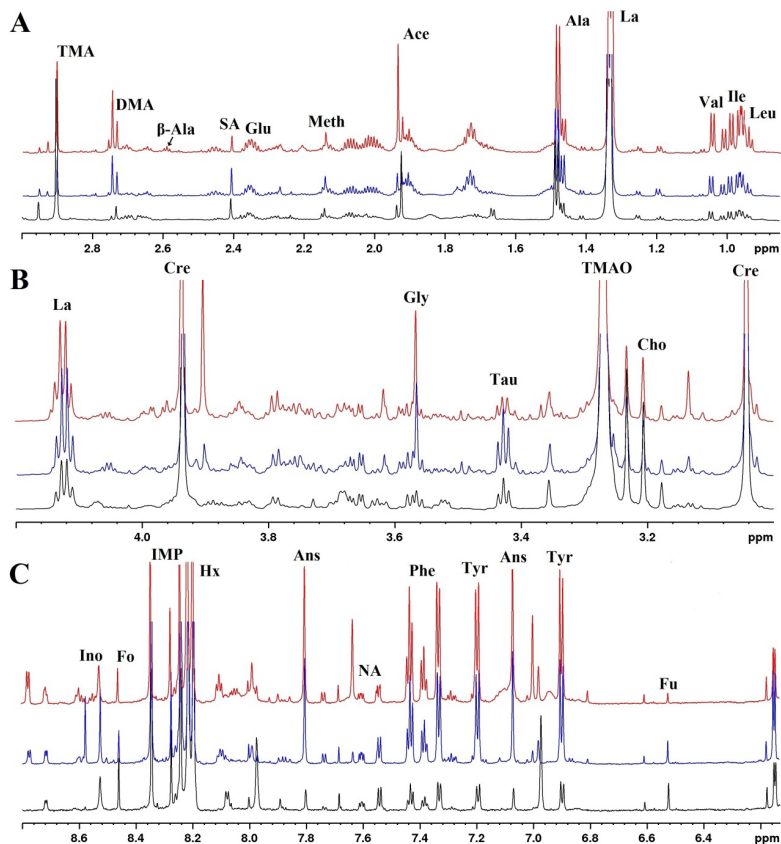


Figure 1. High-field (A), mid-field (B), and low-field (C) regions of the ^1H -NMR spectrum of the extract in TCA of the muscle tissue of catfish samples: black - № 311, blue - № 312, red - № 313

Designations: Leu (leucine), Ile (isoleucine), Val (valine), La (lactic acid), Ala (alanine), Ace (acetic acid), Meth (methionine), SA (succinic acid), DMA (dimethylamine), TMA (trimethylamine), Cre (creatine), TMAO (trimethylamine oxide), Glu (glutamic acid), β -Ala (β -alanine), Fu (fumaric acid), Tyr (tyrosine), Phe (phenylalanine), Tau (taurine), Gly (glycine), Ino (inosine), IMP (inosine-5'-monophosphate), Hx (hypoxanthine), Fo (formic acid), Na (nicotinic acid), Cho (choline), Ans (anserine)

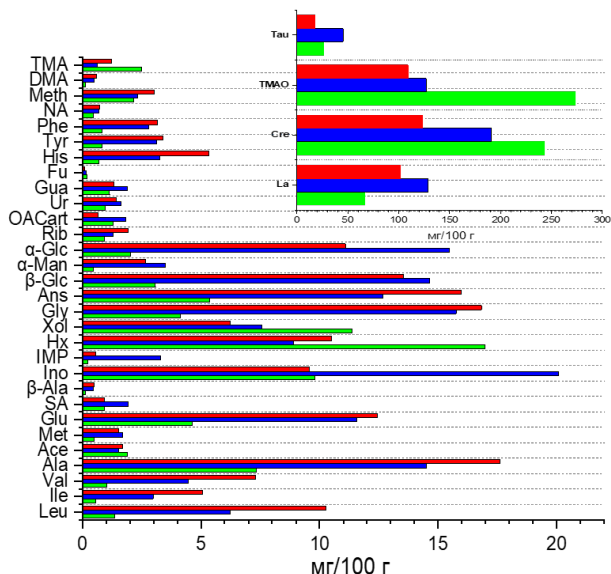


Figure 2. Quantitative content of identified metabolites in catfish samples: green - № 311, blue - № 312, red - № 313.

Designations: Leu (leucine), Ile (isoleucine), Val (valine), La (lactic acid), Ala (alanine), Ace (acetic acid), Meth (methionine), SA (succinic acid), DMA (dimethylamine), TMA (trimethylamine), Cre (creatine), TMAO (trimethylamine oxide), Glu (glutamic acid), β-Ala (β-alanine), Fu (fumaric acid), Tyr (tyrosine), Phe (phenylalanine), α-Man (α-mannose), α-Glc (α-glucose), Tau (taurine), Gly (glycine), Ino (inosine), IMP (inosine-5'-monophosphate), His (histidine), Hx (hypoxanthine), Fo (formic acid), Na (nicotinic acid), Xol (choline), Ans (anserine), Rib (ribose), OACart (o-acetyl-L-carnitine), Ura (uracil), Gua (guanosine)

The processing of the data array was carried out by the principal component method (PCM), which is one of the most widely used chemometric methods for analyzing a large data array. From the constructed combined graph of scores and loads (biplot) for catfish with different arsenic content, it follows that the following metabolites make the main contribution to the main component (F1): glycine, β-alanine, glutamic acid, and tyrosine (figure 3).

Previously, it was shown that with the accumulation of arsenic in the body of fish, the content of a number of amino acids changes, which leads to a decrease in the metabolism of electrophilic compounds and disruption of DNA and protein synthesis.

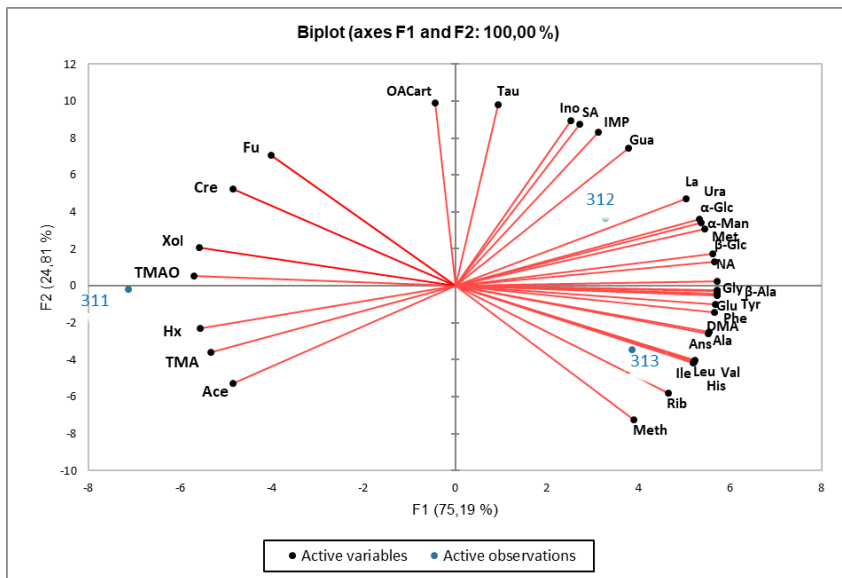


Figure 3. Biplot (combined graph of scores and loads) for clustering according to the content of arsenic in catfish according to table 1. Designations correspond to figure 1

Obtaining an additional array of data on metabolites in samples with different arsenic contents will make it possible to most reliably reveal the mechanism and draw a conclusion about possible disturbances in the metabolism of fish and the consequences for their biological state.

Conclusion

An analysis of the metabolic profile of catfish samples with different contents of total arsenic in muscle tissue: 4.2, 9.5 and 47.5 mg/kg was carried out by NMR spectroscopy. It has been shown that with an increase in the content of arsenic in catfish, there is a clear trend towards an increase in the concentration of leucine, isoleucine, valine, alanine, glutamic acid, β -alanine, glycine, anserine, ribose, uridine, histidine, tyrosine, phenylalanine, methionine, dimethylamine. Using the method of principal components, it was found that for catfish with different arsenic content, the following metabolites make the main contribution to the change in the metabolic profile: glycine, β -alanine, glutamic acid, and tyrosine.

References

1. Cappello T. *NMR-Based Metabolomics of Aquatic Organisms* // *eMagRes*. – 2020. – V. 9. – P. 81 – 100.
2. Bothwell J.H.F., Griffin J.L. *An introduction to biological nuclear magnetic resonance spectroscopy* // *Biol. Rev.* – 2011. – Vol. 86. – P. 493 – 510.
3. Ward J.L., Baker J.M. Beale M.H. *Recent applications of NMR spectroscopy in plant metabolomics* // *FEBS J.* – 2007. – Vol. 274. – P. 1126 – 1131.
4. Wang T., Shao K., Chu Q, Ren Y., Mu Y., Qu L., He J., Jin C., Xia B. *Automics: an integrated platform for NMR-based metabonomics spectral processing and data analysis* // *BMC Bioinf.* – 2009. – Vol. 10. – P. 83.
5. Simmler C, Kulakowski D, Lankin DC, McAlpine JB, Chen SN, Pauli GF. *Holistic Analysis Enhances the Description of Metabolic Complexity in Dietary Natural Products* // *American Society for Nutrition. Adv Nutr.* – 2016. – V.7. – P.179–89.
6. Toth G., Hermann T., Da Silva M.R., Montanarella L. *Heavy metals in agricultural soils of the European Union with implications for food safety* // *Environ. Int.* – 2016. – Vol. 88. – P. 299 – 309.
7. Rai P.K., Kumar V., Lee S., Raza N., Kim K.H., Ok Y.S., Tsang D.C.W. *Nanoparticle-plant interaction: implications in energy, environment, and agriculture* // *Environ. Int.* – 2018. – Vol. 119. – P. 1–19.
8. Rahman Z., Singh V.P. *The relative impact of toxic heavy metals (THMs) (arsenic (As), cadmium (Cd), chromium (Cr) (VI), mercury (Hg), and lead (Pb)) on the total environment: an overview* // *Environ. Monit. Assess.* – 2019. – Vol. 191. – P.419.
9. EFSA. *Scientific opinion on arsenic in food. EFSA panel on contaminants in the food chain.* 2009. – 7(10). - 1351 P. [Electronic resource] – URL: <https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2009.1351> (appeal date 14.03.2022).
10. Ciampa A., Picone G., Laghi L., Nikzad H., Capozzi F. *Changes in the Amino Acid Composition of Bogue (Boopsboops) Fish during Storage at different Temperatures by ¹H-NMR Spectroscopy* // *Nutrients.* – 2012. – N 4(6). – P. 542 – 553.
11. Ghosh D., Ghosh A., Bhadury P. *Arsenic through aquatic trophic levels: effects, transformations and biomagnification—a concise review* // *Geosci. Lett.* – 2022. – N. 9. – P.20.
12. Kumari B., Kumar V., Sinha A.K., Ahsan J., Ghosh A.K., Wang H, DeBoeck G. *Toxicology of arsenic in fish and aquatic systems* // *Environ Chem Lett.* – 2017. – N. 15. – P. 43 – 64.

伏尔加-乌拉尔前缘以北局部重力异常区深部构造地质和密度模型
**GEOLOGICAL AND DENSITY MODELS OF THE DEEP
STRUCTURE IN THE AREA OF LOCAL GRAVITY ANOMALIES
IN THE NORTH OF THE VOLGA-URAL ANTECLISE**

Konanova Nadezhda Vitalievna

*Candidate of Geologo-Mineralogical Sciences, Senior Research Officer
Institute of Geology of the Komi Science Center of the Ural Branch of
the Russian Academy of Sciences, Syktyvkar*

抽象的。由于对 Zimstan 结内伏尔加-乌拉尔前缘 (科米共和国南部) 的详细工作, 发现了强烈的局部重力异常 (Frolovskaya、Chetdinskaya、Lokchinskaya 等), 有望探测到尸体地质和地球物理作品生产中的主要 (超基性 (?)) 成分。其中, 在 Microsoft EXCEL 程序中创建了一个任意单位的重力场及其直角坐标的 XYZ (记录和外推) 数据库, 具有 1600 多个值, 并以此为基础创建网格文件形成了基础 Golden Software SURFER 程序中的计算, 用于构建深层结构模型。

由于对 Kirov-Kazhim 槽结构三重交界区域的重力场进行了解释, 伏尔加 - 乌拉尔前缘的 Komi-Permyatsky 圆顶与 Mezen 同步的 Vychegodsky 槽 [10, 11, 15], 由于 Lokchim “trapp” 场 [2, 16] 的高磁化岩石的存在而复杂化, 在该地区深部结构几乎完全没有地震剖面、地质和地球物理模型的情况下建立了三个强度增加的局部重力异常, 并考虑了它们的成矿特征。

关键词: 深部构造, 构造, 断裂带, 异常引力场。

Abstract. *As a result of detailed work on the northeastern outskirts of the Volga-Ural antecline (south of the Komi Republic) within the Zimstan knot, intense local gravity anomalies (Frolovskaya, Chetdinskaya, Lokchinskaya and others) were revealed, promising for the detection of bodies of the main (ultrabasic (?)) composition in the production of geological and geophysical works. Within them, a database of XYZ (recorded and extrapolated) in arbitrary units of the gravity field and their rectangular coordinates was created in the Microsoft EXCEL program, with more than 1600 values, and the creation of grid files based on them formed the basis for calculations in the Golden Software SURFER program for the purpose of constructing models of the deep structure.*

As a result of the interpretation of the gravity field in the area of the triple junction of the structures of the Kirov-Kazhim trough, the Komi-Permyatsky dome of the Volga-Ural antecline with the Vychegodsky trough of the Mezen syncline

[10, 11, 15], complicated by the presence of highly magnetized rocks of the Lokchim "trapp" field [2, 16], in the conditions of the almost complete absence of seismic profiles, geological and geophysical models of the deep structure in the area of three local gravity anomalies of increased intensity were built and their mineragenic features were considered.

Key words: deep structure, tectonics, fault zones, anomalous gravitational field.

Introduction. On the territory of the northeastern margin of the Russian Plate according to geological and geophysical data as a result of the interpretation of maps of magnetic and gravimetric fields of various scales, cosmogeological maps and maps of fault tectonics, as well as as a result of studying the features of the deep structure of the earth's crust, lithospheric and sublithospheric upper mantle according to geophysical data, two systems of orthogonal faults are traced [8] – submeridional-sublatitudinal (N–S, W–E) and diagonal (NW–SE, NE–SW). The Zimnibrezhno-Krasnovisherskaya linear fault zone is most contrasting in the geophysical fields, within which we managed to identify the intersection nodes of deep faults: Zimnibrezhny, Vashkinsky and Zimstansky (Fig. 1), probably having similar mineragenic specifics. In the vicinity of the Zimstan junction, intense local gravity anomalies (Frolovskaya, Chetdinskaya, Lokchinskaya and others) were revealed (Fig. 2), promising for the detection of bodies of basic (ultrabasic (?)) composition in the course of geological and geophysical works.

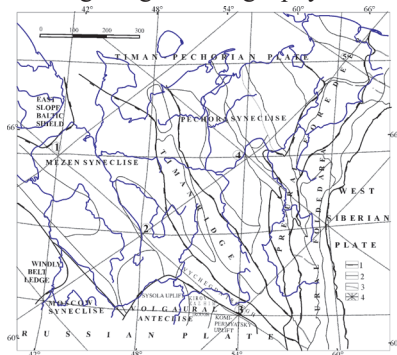


Figure 1. Scheme of location of orthogonal faults and nodes of their intersection in the European North-East of Russia [4, 5, 6, 7, 8, 10, 11, 13, 15 and etc].

Legend: boundaries of structures: 1 - supra-order; 2 - I order; 3 - transverse Ural's; 4 - orthogonal faults and nodes of their intersections: 1 - Zimnibrezhny, 2 - Vashkinsky, 3 - Zimstansky, 4 - Izhma-Pechora, 5 - Korotaikhinsky.

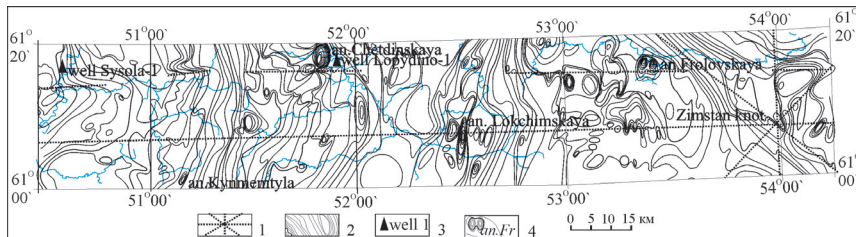


Figure 2. Scheme of localization of the Zimstan node of intersection of orthogonal faults.

Legend: 1 - faults and Zimstan node of their intersections; 2 – gravity field anomalies [3], isolines are drawn through 1 mGal; 3 – parametric wells; 4 – local anomalies of the gravimetric field.

As a result of field reconnaissance geological and geophysical work and schlich sampling in the Frolovsky area near the Zimstan intersection of orthogonal faults, we have identified a cluster of local magnetic anomalies enriched in unrounded chrome spinels of an ideal octahedral habit, the Cr₂O₃ content in some of them exceeds 64% [9, 12].

On the periphery of the intense Chetda gravity anomaly, as a result of field geological and geophysical studies, the Chetda radon anomalous region was discovered [14] comparable with data on radon volumetric activity within the known radium field in the village of Vodny, Ukhta region of the Komi Republic.

It is quite obvious that the northern part of the Volga-Ural anteclise of the Russian Plate, in the conditions of the almost complete absence of seismic profiles and deep drilling, requires specialized complex research work and detailed geological and geophysical studies to determine the mineragenic specifics of the region. The advantage of the gravimetric method is that it can be used to obtain important geological information about deep structures in those regions where seismic surveys are not available and are not planned. Therefore, we attempted gravity sounding in the area of three identified local anomalies of the gravity field by sequentially excluding anomalous components from the observed field in order to construct deep geodensity sections. This article presents the results of the research.

Research methodology. When interpreting, gravimetric maps were used in the Bouguer reduction (gravity field V_z) 1:200000 and 1:1000000 scales [3], which were used to solve all problems related to the identification of density inhomogeneities in the sedimentary cover and the upper parts of the consolidated earth's crust.

To calculate the regional background (V_z rf), the operation of simple arithmetic mean averaging was used with a step of 1 km in a sliding window 11x11 or

15x15 in the center of the palette. The size of the palette window was determined by the size of the research objects. The difference between the observed value of the field in the center of the palette (V_z) and the regional background ($V_{z\text{ rf}}$) is the local anomaly ($V_{z\text{ loc}}$), which was used in constructing the density section. Residual and regional anomalies were again processed to study deeper horizons. The principle of successive exclusion of anomalous components from the observed (residual) gravity field was used by the author in interpreting the gravitational field. An increase in the depth of research occurred due to operations with residual anomalies by performing calculations to calculate the regional background and local anomalies at a level of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 km, according to which sections of anomalous objects.

Vertical and horizontal derivatives of the first (V_{zz} , V_{zx}) and second order (V_{zzz} , V_{zxx}) were calculated to delineate blocks with different values of rock density over the area and in the section, which made it possible to more correctly interpret the zoning of the territory. It is known that the zero crossing points of the second derivatives and the extrema of the first derivatives reflect block boundaries and fault zones. The construction of density boundaries was carried out according to the gradients of the first and second orders, as well as according to the calculated local anomalies due to the influence of anomalous masses with increased and decreased density values.

Research results and discussion. In the geological structure of the north of the Volga-Ural anticline and the adjacent part of the Vychegodsky trough of the Mezen syncline, two structural-formational stages take part.

The lower one corresponds to the crystalline basement of the platform and, according to the available ideas, is composed of metamorphogenic rocks of the Archean and Lower Proterozoic. The depth of the crystalline basement on the anticline is 1.5–3.5 km, and in the Vycheгда trough it is 3.5–4.5 km or more. The upper structural-formational stage is represented by formations of the sedimentary cover of the Riphean-Vendian, Devonian, Carboniferous and Permian ages, overlain by Quaternary deposits [1, 10, 11, 15]. When constructing density sections, the AR–PR1 boundary of the crystalline basement is most clearly identified, and two more boundaries are traced in the sedimentary cover, associated with the top of the R–V and, probably, Permian deposits.

Previously, we [8] carried out the detailing of the gravity field in the Bouguer reduction with the density of the intermediate layer $\sigma=2.3 \times 10^{-3} \text{ kg/m}^3$ along the strike of the latitudinal fault and localization of the location of the Zimstan node. The Zimstan area of the intersection of orthogonal faults is characterized by a complex structure of the gravity field (Fig. 2), confined to the junction zone of the superorder structures of the Volga-Ural anticline and the Mezen syncline, the boundary between which is drawn along a series of deep faults of northwestern

strike, characterized by a zone of high gravity gradient fields. The sublatitudinal fault is quite confidently traced along the anomaly pinch zones, areas of intensity attenuation and ruptures of linear anomalies, elbows of capture. Frolovskaya, Chetdinskaya, Lokchinskaya and other intense local gravitational anomalies, having small dimensions in diameter (2–4 km), were found on the detail strip, which we named after the nearest settlements.

The Frolovskaya local anomaly of the gravity field is located near the Zimstan intersection of systems of orthogonal deep faults in the area of the triple junction of the Kirov-Kazhinsky trough and the Komi-Permyatsky arch of the Volga-Ural anticline with the Vychevodsky trough of the Mezen syncline, complicated by the presence of highly magnetized rocks of the Lokchim trap field. In the block structure of the Archean-Early Proterozoic crystalline basement of the Russian Plate, the site area is located in the zone of edge dislocations of the northeastern extremity of the Volga-Ural anticline. In the structure of the sedimentary cover, it is confined to the northeastern side of the Kirov-Kazhinsky trough or to the slope of the Komi-Permyatsky dome, being in the area of junction with the Vychevodsky trough of the Mezen syncline (Fig. 1).

The shape of the Frolovskaya anomaly resembles the shape of a horseshoe (3*3.5 km) with two intense maxima (1*2 km). Faults within the anomalous zone are represented by sublatitudinal, submeridional and diagonal (NW-SE) systems of discontinuities (Fig. 3A), obtained as a result of a complex interpretation of derivatives of the first and second orders. The density section (Fig. 3B) crosses two epicenters of the horseshoe anomaly with maximum values of the gravity field strictly from west to east. Its length is 16 km, and the depth of research reaches 7 km. Calculations have shown that the Frolovskaya anomaly is located between two systems of deep faults with a subvertical strike. It was possible to identify and trace along the profile the behavior of the surface of the crystalline AR-PR1 basement, which lies here at a depth of 2.1 to 3.5 km. In the zone of the eastern fault system, there is a loss of correlation of the boundary of the crystalline basement, probably, the mathematical apparatus for calculating derivatives could not cope with the complex geological conditions in this section of the profile, since it is here that the zone of edge dislocations of the Volga-Ural anticline and its junction with the Vychevda trough of the Mezen syncline is located.

The anomalous objects of the Frolovskaya local gravity anomaly are located within the sedimentary cover, limited by vertical crustal faults and the surfaces of two geodensity boundaries within the sedimentary cover, associated with the top of the R-V and, probably, Permian deposits. But their inversion character of strike in the section and insignificant thickness up to 800 m at the epicenter of two intense positive gravity anomalies versus 1700 m in the central part of the “horseshoe” with low field values, allow us to conclude that the sedimentary rocks

within this interval of the section are probably contain elements of rocks of basic (ultrabasic (?)) composition.

Apparently, the pre-Mesozoic within-plate magmatism of the East European Platform, revealed by the results of high-precision aeromagnetic survey [2, 16], is also reflected by the results of interpretation of the gravity field of the Frolov local anomaly in the zone of the triple junction of tectonic structures.

The **Chetda** local isometric anomaly of the gravity field is located within the eastern side of the Kirov-Kazhimsky trough in the field of development of stripe anomalies of the gravity field (Fig. 1, 2), elongated in the meridional direction. The anomaly has a pear-shaped shape (4*4 km) with one intense maximum (1.5*1.5 km) in plan view.

The density section (Fig. 4B) crosses the anomaly from southwest to northeast. Its length is 18.5 km, and the depth of research is 10 km. The surface of the crystal-line AR-PR1 basement lies here, according to gravimetric data, at a depth of 2.2 to 2.8 km. It was possible to identify and trace along the profile two more density boundaries within the sedimentary cover, associated with the top of the R-V and, probably, Permian deposits. In the zone of the southwestern fault system, there is a loss of correlation of these gravity boundaries in the upper part of the section.

Anomaly-forming objects are located here deeper than in the area of the Frolovskaya anomaly, in the field of development of the Riphean-Vendian deposits of the sedimentary cover, they are limited by deep vertical faults. It is here, in the area of the greatest subsidence of the roof of the consolidated basement (2.5–2.7 km) in the zone of high gradient of the gravitational field, that there is a system of deep faults with a subvertical strike, which probably determines tectonic movements in this region. Surprisingly, in the upper part of the section, in the zone of distribution of rocks of the upper structural stage (V3 - P2), according to gravity data, vertical faults up to 1 km long are clearly identified, making it difficult to trace the main structural-formation stages. According to these faults, one can probably assume the penetration of various types of fluidizates with elements of basic and ultrabasic rocks from a high-density reservoir into the near-surface parts of the geological section in this region. Probably, as they move upward, they retouch the uppermost gravity-active boundary (Fig. 4B) until it completely disappears, which is quite clearly fixed in neighboring areas.

The **Lokchim** system of local anomalies is located on a sublatitudinal fault near the Zimstan node of intersection of deep faults and consists of two closely spaced intense local anomalies of different signs. In the block structure of the Archean-Early Proterozoic crystalline basement of the Russian Plate, the site area is located in the junction of the Kirov-Kazhimsky trough and the Komi-Permyatsky arch of the Volga-Ural antecline; in the structure of the sedimentary cover, it is confined to the transition zone from the Namskaya step of the Kirov-Kazhimsky trough to the Lokchimsky uplift of the Komi - Permian vault.

The anomaly of increased values of the gravity field is less intense and more isometric (2×4 km), the anomaly of low values of the gravitational field (2×6 km) is gradient and locally elongated in the meridional direction. Faultings within the anomalous zone are represented by sublatitudinal and submeridional rupture anomaly systems (Fig. 5A). The density section (Fig. 5B) crosses two epicenters with maximum and minimum values of the gravity field from west to east. Its length is 14.5 km, and the depth of research is 10 km. It was possible to identify and trace along the profile the behavior of the surface of the crystalline AR-PR1 basement, which lies here at a depth of 1.7 to 1.9 km. In the fault zone, there is a loss of correlation of the basement boundary. It is likely that it was processed during complex geological processes in this section of the profile. Most likely, it is here that the zone of edge dislocations and movements from the side of the Komi-Permyatsky arch and its junction with the Kirov-Kazhimsky trough of the Volga-Ural antecline is located.

Anomaly-forming objects of the Lokchim local gravity anomaly with low density values are located within the sedimentary cover, limited by crustal faults and the surfaces of two identified geodensity boundaries inside the sedimentary cover, associated with the roof of the AR-PR1 basement and, probably, Permian deposits. Due to the thinness of the Riphean-Vendian deposits or their complete absence in this study area, according to the R-V gravity data, the boundary in the Lokchim area cannot be identified. However, the presence in the upper part of the section of discontinuities in the distribution of the boundaries of structural-formation zones near faults, the nature of the strike in the section and insignificant thicknesses up to 1500 m indicate that sedimentary rocks within this interval of the section may contain elements of rocks with abnormally low values of rock density (defluidizates, tuffizites, etc.).

Conclusions. As a result of the detailed work carried out on the northeastern margin of the Russian Plate (south of the Komi Republic), the location of the Zimstan deep fault intersection node was localized and intense Frolovskaya, Chetdinskaya, Lokchimsкая and other local anomalies of the gravity field were revealed in its vicinity. Within their limits, the interpretation of gravitational data was carried out, during the implementation of which the anomalous components are consistently excluded from the observed gravitational field and the depth of research is increased. Calculations of horizontal and vertical derivatives of the first and second orders, local, regional and residual anomalies were carried out. This made it possible to build geodensity sections to a depth of 10 km and extract information about the features of the deep structure of poorly studied objects.

The source of the Lokchim anomaly is a gravity-deficient body with a density deficit at a depth of 1 km, the roots of which go down to a depth of 10 km in the field of decompacted rocks. The Chetdinskaya and Frolovskaya gravimetric

anomalies are caused by gravity-active objects with excess density values located within the sedimentary cover at a depth of 1 km and 2 km, respectively, in the field of development of relatively dense rocks.

According to the results of the interpretation of the gravity field, the mirogenic specificity of the Chetda object is most likely associated with the formation of the R-V rocks of the Kirov-Kazhim trough of the Volga-Ural antecline; with the Vychegodsky trough of the Mezen syncline, and the Lokchinsky trough with the products of defluidization of decompacted rocks in the zone of responsibility of the steep western side of the Komi-Permyatsky dome of the Volga-Ural antecline.

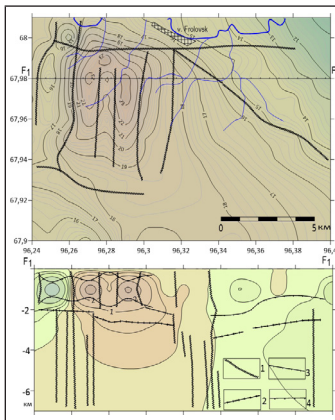


Figure 3. A – Results of interpretation of the V_z field, Frolovsk area. B - Geodensity section along the F1 profile line. Legend: 1—faults, 2—top of the AR-PR1 basement, 3—top of the R-V deposits, 4—top of the P2(?) complex.

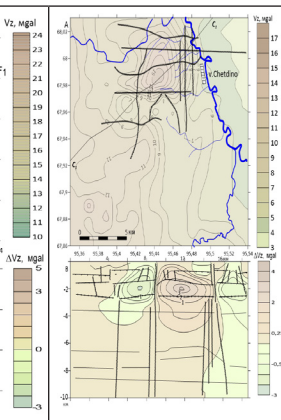


Figure 4. A - Results of interpretation of the V_z field, Chetdin area. B - Geodensity section along the C1 profile line. Legend in Fig.3.

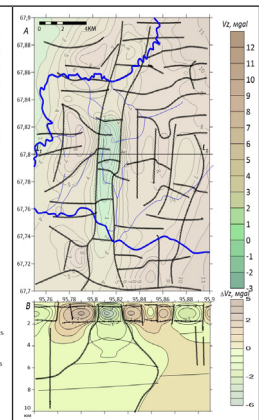


Figure 5. A - Results of the interpretation of the V_z field, Lokchim area. B - Geodensity section along the L1 profile line. Legend in Fig.3.

References

1. Bogatsky V.I., Bogdanov B.P. Clarification of the geological structure and prospects for the oil and gas potential of the Kazan-Kazhimsky aulacogen and its framing. Ukhta: TP NITs-2, 2003.
2. Bush V. A., Kalmykov B. A. New data on pre-Mesozoic intraplate magmatism of the East European Platform / Geotectonics. No. 5. 2015, pp. 43–61.
3. Gravimetric map of Russia linked to maps for the territory of the CIS countries. M: 1:1000 000 / Ch. ed. O.V. Petrov. Federal Agency for Subsoil Use. Federal

State Unitary Enterprise “All-Russian Research Geological Institute named after A.P. Karpinsky” (FSUE “VSEGEI”). 2008.

4. Konanova N. V., Udoratin V. V. Zoning of the crystalline basement of the Timan-Severokralsk segment of the lithosphere and adjacent territories according to geophysical data / *Bulletin of the IG Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences*. Syktyvkar, 2014. No. 6. pp. 3-7

5. Konanova N. V. Deep structure of Pai-Khoi and adjacent territories. Syktyvkar, 1997. 96p.

6. Konanova N.V. Volumetric models of the gravimetric field of the Timan-Severouralsk region and adjacent territories // *Bulletin of the IG Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences*. 2010. No. 9. P.3-5

7. Konanova N. V. Density inhomogeneities of the lithosphere of the Timan-Severoural region // *Otechestvennaya geologiya*, No. 6, 2007. p. 28-33.

8. Konanova N. V. Crossing nodes of orthogonal faults of the European North of Russia according to geophysical data / *Bulletin of the IG Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences*, No. 7. Syktyvkar, 2019. pp. 8-14.

9. Konanova N. V., Udoratin V. V., Magomedova A. Sh. Magnetic anomalies of the junction zone of the northeastern part of the Volga-Ural anteklise and the Vychegodsk trough / *Bulletin of the IG Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences*, No. 12. Syktyvkar, 2017. pp. 25-30.

10. Structure of the Platform Cover of the European North of the USSR, Under ed. V. A. Dedeeva. L.: Nauka, 1982. 200p.

11. Tectonic map of the Pechora plate / Dedeev V.A., Yudin V.I., Bogatsky V.I. etc. Komi Branch of the Academy of Sciences of the USSR. Syktyvkar. 1985.

12. Typomorphic features of gold in alluvial deposits of the Frolovsky area (Ust-Kulomsky district, Komi Republic) / N.S. Kovalchuk, S.I. Isaenko, N.V. Konanova, T.G. Shumilova, Yu.V. Danilova // *Bulletin of the IG Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences*. No. 1. 2019 P. 35-43.

13. Udoratin V. V., Konanova N. V. Deep structure of the lithosphere along the MEZTIMPECH profile / *Otechestvennaya geologiya*. No. 1. 2000. pp. 15-23.

14. V. V. Udoratin, Yu. E. Ezimova, and A. Sh. Magomedova, Radon Survey for Mapping Fault Zones of the Timan-Severoural Region. Syktyvkar, 2021. 153 p.

15. Foundation of the Timan-Pechora oil and gas basin / L.T. Belyakova, V.I. Bogatsky, B.P. Bogdanov, E.G. Dovzhikova, V.M. Laskin. Kirov: Kirov Regional Printing House OJSC, 2008. 288 p.

16. Tsyganov, V.A., New data on the geological structure of the territory of the Mezen syncline and its prospects for hydrocarbons (according to the results of high-precision aeromagnetic survey), *Georesursy*. 2006. No. 1(18). pp. 26–35.

科学出版物

上合组织国家的科学研究：协同和一体化

国际科学大会的材料

2022 年 10 月 26 日，中国北京

编辑 A. A. Siliverstova

校正 A. I. 尼古拉耶夫

2022 年 10 月 26 日，中国北京

USL。沸点：98.7。 订单253. 流通500份。

在编辑和出版中心印制

无限出版社



